Educ.

The American Biology Teacher

JANUARY, 1961 VOLUME 23, NO. 1

TABLE OF CONTENTS

THE AMERICAN BIOLOGY TEACHER

Publication of the National Association of Biology Teachers.

Issued monthly during the school year from October to May. Second class postage paid at Danville, Illinois.

Publication Office—Interstate Press, 19 N. Jackson St., Danville, Ill.

Editor—PAUL KLINGE, Coordinator for School Science, Indiana University, Bloomington, Indiana.

The Indiana University address will be the official editorial office.

Managing Editor—MURIEL BEUSCHLEIN, 6431 S. Richmond, Chicago 29, Ill.

Subscriptions, renewals, and notices of change of address should be sent to the Secretary-Treasurer, HERMAN KRANZER, Department of Education, Temple University, Philadelphia 22, Pennsylvania. Correspondence concerning advertising should be sent to the Managing Editor.

Annual membership, including subscription, $6.00; subscription to Journal, $6.00; individual copies $.75; outside United States, $6.75; student membership, $3.00.

A Report on the Status of Advanced Biology in Large Secondary Schools of the United States

JERRY P. LIGHTNER
Great Falls High School, Great Falls, Montana

I. *Introduction*

In 1952 Martin reported, "The course in advanced biology . . . is a comparatively recent addition to the curriculum. It is offered more frequently in large high schools than in small high schools." (1)

In a recent article the author (2) presented the results of a survey on advanced biological science courses in large secondary schools. This survey of 1217 schools indicated that 171 of them offered advanced biology.

Advanced biology is defined as a one or two semester biology course requiring as a minimum prerequisite the completion of a course in General Biology. The survey also revealed that this course may have five different titles. These are Advanced Biology, Biology II, College Biology, Biology 3 and 4, and Biology III.

As a result of their prevalence a status study of these courses was undertaken. During the academic year 1959-1960 a questionnaire was sent to the chairman of the biology department in each of the schools offering advanced biology. One hundred thirty-five complete and usable questionnaires were returned. Therefore this article constitutes a summary statement on the status of advanced biology in 135 large secondary schools in the continental United States.

II. *Reasons for Offering Advanced Biology*

Speculation as to why the advanced biology course has been added in many large secondary schools prompted Fordyce (3) to list several possible reasons for its appearance. These included the nurturing of student interest in biology; enabling the student to gain either advanced standing and/or credit in biology upon entering college; providing for an additional course for the senior student who has completed three years of intensive course work; and attempting to extend the first year course into untouched areas. Kastrinos has reported offering a second year course "for the student interested in some phase of biology as a future." (4)

One hundred thirty-five teachers of advanced biology were asked to state the primary reason for offering their course. Eleven teachers reported their courses were designed for both the general education of terminal students and the specialized education of college preparatory students. The remaining 124 teachers stated the primary purpose of their advanced biology was college preparation or pre-professional education. Therefore over 91 per cent of advanced biology courses are designed for college-bound students.

Seventeen teachers reported that at least some of their students took the Advanced Placement Program Test in Biology (APPTB); six teachers specifically stated that their course was advanced placement biology. Ninety-five students in seventeen schools took the APPTB and over 4400 students in the remaining 118 schools did not take this test during the academic year 1958-1959. Fifty-nine students were reported to have received advanced standing and/or credit upon entering college; of these, forty-seven had also taken the APPTB. It becomes apparent that students accorded the advantages of the Advanced Placement Program are much more successful in obtaining college credit and course waiver. Perhaps more teachers of advanced biology should acquaint themselves with this program so that their better students could subsequently benefit.

III. *Textbooks and Reference Materials*

Textbooks have long played a leading role in our secondary schools. American teachers have traditionally relied on them to a much greater extent than have their European

TABLE 1

Primary Textbooks Used in Advanced Biology Courses

Textbook Used: Title / Author(s) / Publisher	Textbook Level H = High School C = College	Frequency of Use		
		When One Textbook Is Used	When More Than One Text Used	Total Number Schools Using Text
1. LIFE Simpson, et al. Harcourt-Brace	C	13	2	15
2. GENERAL BIOLOGY Johnson, et al. Henry Holt	C	8	1	9
3. GENERAL BIOLOGY Mavor Macmillan	C	7	1	8
4. MODERN BIOLOGY Moon, et al. Henry Holt	H	7	1	8
5. HUMAN PHYSIOLOGY Morrison, et al. Henry Holt	C	6	2	8
6. THE SCIENCE OF BIOLOGY Weisz McGraw-Hill	C	6	1	7
7. PRINCIPLES OF BIOLOGY Whaley, et al. Harper	C	5	1	6
8. BIOLOGY Villee Saunders	C	5	1	6
9. PRINCIPLES OF MODERN BIOLOGY Marsland Henry Holt	C	4	1	5
10. BIOLOGY Brown Heath	C	4	1	5
11. ANIMALS WITHOUT BACKBONES Buchsbaum U. of Chicago	C	1	4	5
12. BIOLOGY MacDougall & Hegner McGraw-Hill	C	4	1	5
13. BIOTIC WORLD AND MAN Milne & Milne Prentice-Hall	C	4	0	4
14. BIOLOGY Winchester D. Van Nostrand	C	4	0	4

counterparts. As a result the textbook has become, "in the final analysis, the most influential factor in determining what is to be taught in any science." (5)

Leaders in science education have recommended that a textbook be used as the basis for a science program. Debatable as this point of view may be, Thurber and Collette state, "A textbook is fundamentally a course of study, designed to stand alone without implementation." (6)

In view of the fact that textbooks are primary tools of science teaching, a survey of the principal textbooks used in advanced biology courses was undertaken. Table 1 lists the fourteen most commonly used textbooks,

TABLE 2

Principal Reference Textbooks Used in Advanced Biology Courses

Textbook	Frequency of Use
1. LIFE Simpson, et al. Harcourt-Brace	20
2. THE SCIENCE OF BIOLOGY Weisz McGraw-Hill	19
3. COLLEGE ZOOLOGY Hegner & Stiles Macmillan	17
4. ANIMALS WITHOUT BACKBONES Buchsbaum U. of Chicago	15
5. ELEMENTS OF ZOOLOGY Storer & Usinger McGraw-Hill	14
6. GENERAL BIOLOGY Mavor Macmillan	11
7. COLLEGE BOTANY Fuller & Tippo Henry Holt	10
8. BIOLOGY Brown Heath	9
9. BOTANY Robbins, et al. Wiley	8
10. BIOLOGY Winchester D. Van Nostrand	8
11. BOTANY Wilson Dryden Press	7
12. BIOTIC WORLD AND MAN Milne & Milne Prentice-Hall	7
13. MODERN BIOLOGY Moon, et al. Henry Holt	7
14. BIOLOGY Villee Saunders	6
15. PRINCIPLES OF MODERN BIO. Marsland Henry Holt	6
16. TEXTBOOK OF PHYSIOLOGY Kimber, et al. Macmillan	5
17. THE PLANT WORLD Fuller Henry Holt	5
18. MAN AND HIS BIO. WORLD Harrah, et al. Ginn	5
19. GENERAL ZOOLOGY Storer McGraw-Hill	5
20. THE LIVING BODY Best & Taylor Henry Holt	5
21. GENERAL BIOLOGY Johnson, et al. Henry Holt	5
22. PRINCIPLES OF GENETICS Sinnott, et al. McGraw-Hill	4
23. ANATOMY OF HUMAN BODY Gray Lea & Febiger	4
24. BACTERIOLOGY Bryan & Bryan Barnes and Noble	4
25. HUMAN PHYSIOLOGY Morrison, et al. Henry Holt	4
26. MAN AND THE VERTEBRATES Romer U. of Chicago	3
27. MACHINERY OF THE BODY Carlson & Johnson U. of Chicago	3
28. PRINCIPLES OF BIOLOGY Whaley, et al. Harper	3
29. SOURCEBOOK FOR BIO. SC. Morholt, et al. Harcourt-Brace	3
30. THE HUMAN ORGANISM DeCoursey McGraw-Hill	2
31. GENETICS Winchester Houghton-Mifflin	2
32. PRINCIPLES OF ZOOLOGY Hickman Mosby	2
33. GREAT EXPERIMENTS IN BIO. Gabriel & Fogel Prentice-Hall	2
34. GENERAL ZOOLOGY Miller & Haub Henry Holt	2
35. TEXTBOOK OF PHYSIOLOGY Zoethout & Tuttle Mosby	2
36. HOW LIFE BEGAN Adler Signet	2

their educational level, and their frequency of use. A total of thirty-seven different textbooks were reported as being the primary or co-primary advanced biology text by 112 secondary schools. Teachers in twenty-three schools reported that no specific textbook was used.

The fourteen texts listed in Table 1 are being used by 73.0 per cent of schools reporting the use of a textbook. As might be expected all but one are considered to be college level; with two exceptions all are general biology texts. Nine schools reported using a combination of two texts, three schools use three different books, and one school reported assigning four textbooks to the students.

No one textbook can possibly cover the materials of a course of study in precisely the manner or sequence proposed by all teachers. Therefore reference textbooks assume increased importance. Frankel (7) has said that separate supplementary reference books in advanced biology are most desirable and helpful.

A total of seventy-two different textbooks were reported being used as references. Table 2 lists thirty-six of the most common reference texts. These thirty-six constituted 85.5 per cent of the total reported.

Journals and magazines are extremely helpful in many academic courses. The latest developments from research may reach the reader of a periodical one to three years before they appear in a textbook. A single subject may be discussed in much greater depth in a journal than in a textbook. Illustrations are often more numerous in magazines than in books. Consequently magazines and journals can be very valuable supplements to advanced biology courses.

One hundred twenty-nine teachers reported their students made frequent use of regularly published periodicals. Table 3 lists the names of these publications and their frequency of use.

An investigation into the use of films and laboratory manuals was made. It was found that neither of these teaching aids are extensively used. Only twenty-six teachers, constituting less than 20 per cent of the sample, reported the use of a laboratory manual in advanced biology. Three-fourths of teachers replied that they used less than three hours of films during a semester.

IV. *Programming Advanced Biology*

Advanced biology is a recent addition to the science curriculum. Thirty-three schools reported offering the course for the first time during the 1959-1960 school year. The average length of time for which advanced biology has been offered is 5.3 years. However advanced biology has been included in the science curriculum of one school for thirty years.

TABLE 3

Journals and Magazines Used as Supplemental Reading Material

Name of Periodical	Frequency of Use
Scientific American	114
Science News Letter	91
National Geographic	68
Natural History	67
Nature	56
Science	51
American Biology Teacher	50
Science World	36
Scientific Monthly	23
American Scientist	12
Today's Health	9
Science Digest	7
The Science Teacher	4
Turtox News	4
Current Science and Aviation	2
Life Magazine	2
AMA Journal	2
Biological Abstracts	2
Journal of Biochemistry	1
Canadian Nature	1

One hundred twenty-two schools out of 135 offer advanced biology as a full year course. Twelve schools offer a one semester course. One school reported that their course was designed so that selected students could continue project work into a second year.

There were 116 schools that offer advanced biology every year. Three schools offered the course on alternate years and sixteen offered it only on demand. Fifty-six per cent of schools scheduled a single class of advanced biology per day and an additional 33.1 per cent schedule from two to four classes of the course per day.

The length of the mean class period was found to be 50.6 minutes. The mean laboratory period was 56.9 minutes; only sixteen schools reported a laboratory period double the length of the class period. Three schools

have no laboratory work and three replied that their course was entirely of laboratory nature. A further refinement of data indicated that the average advanced biology student spends 285 minutes per week in regularly scheduled classroom and laboratory periods. Of this total, 166.8 minutes are devoted to classroom activities and 118.2 minutes are spent carrying out laboratory work.

Fordyce (8) feels that the advanced biology class should be scheduled during the final periods of the day to allow a student to continue work uninterrupted into the informal after-school hours. However this practice is not widespread; in the 135 courses studied only twenty-two schools reported such scheduling.

A wide range of class sizes exists, one school reporting only three students in advanced biology to four schools reporting thirty-eight students per class. The mean class size was found to be 23.5 students. In regards to grade level of the students enrolled, 52.1 per cent were twelfth grade students, 38.9 per cent were in the eleventh grade, and 9.0 per cent were tenth grade students.

The degree to which chemistry had been made a prerequisite of advanced biology was also studied. It was found that forty-six secondary schools require either prior or concurrent registration in chemistry for entrance into advanced biology. Because chemistry has become such an integral part of modern biological knowledge, perhaps it would be well for advanced biology teachers to carefully consider adding this prerequisite to their course.

V. *Research Projects and Written Reports*

In the introductory chapters of nearly all secondary school science textbooks will be found a description of the scientific method. Five, six, or seven steps that a scientist uses in research are usually outlined. Apparently many authors consider this presentation sufficient introduction to research for many students. This is doubtful. As Silber points out, "How many high school students would be more interested in science careers if they could really do something creative and challenging?" (9) And Snyder says, "The real opportunity for enrichment comes with the preparation of a research project." (10)

Teachers of advanced biology were questioned on the use they made of research projects. To reduce the chance of misunderstanding, the term "research project" was defined as a problem of such nature that the student must be thoroughly acquainted with the literature on the problem *and* spend considerable time in the laboratory or field in an attempt to arrive at a solution.

Table 4 and Table 5 summarize the results of the inquiry on research projects. It is apparent that the number of teachers requiring individual projects is about equal to those making them optional. In regards to group research projects, Table 5 indicates that these are undertaken in 42.2 per cent of advanced biology courses. This is noteworthy when one considers how commonplace group effort has become in both basic and applied research today.

TABLE 4

The Extent to Which Research Projects Are Undertaken by Individual Students

Action Taken	Frequency	Per Cent
A. Research projects are required of all students	62	45.9
B. Research projects are optional	57	42.2
C. No research projects are undertaken	16	12.0

TABLE 5

The Extent to Which Research Projects Are Undertaken by Groups of Students

Action Taken	Frequency	Per Cent
A. Group research projects are undertaken	57	42.2
B. No group research projects are undertaken	78	57.7

VI. *The Advanced Biology Teacher*

The quality of an advanced biology course depends in no small part on the teacher. To be sure, the physical plant, the textbooks

used, and the laboratory equipment are important, but none surpass the teacher's role. Conant has stated "that on the quality of the teachers the quality of the education must ultimately depend." (11) An attempt was therefore made to ascertain some of the background of the advanced biology teacher.

One hundred eight teachers have earned either a master's or doctor's degree; the remaining possess a bachelor's degree. Seventy per cent of the graduate and 82 per cent of the undergarduate degrees were earned in conjunction with a biology subject matter major. Only three advanced biology teachers replied that they had neither a biology major while earning their degree nor had recently taken college work in biology.

When considering the rapid pace of research and its concomitant increase in biological knowledge, it is encouraging to learn that advanced biology teachers show great inclination to return periodically to school. Table 6 shows that some three-fourths of these teachers have taken biology course work in college within the past six years.

Advanced biology teachers desiring to take college work have received much help in the form of financed study grants. The 135 teachers reported a total of ninety-six grants; the National Science Foundation easily helped the greatest number of teachers, having supplied seventy-one of the grants that were reported.

TABLE 6

Number of Years Since the Teacher Has Taken a Biological Science Course in College

Years Since Such Courses Taken	Frequency	Per Cent of All Teachers
0 – 2	76	56.3
3 – 5	22	16.4
6 – 8	7	5.2
9 – 11	14	10.4
12 – 14	1	0.7
15 – 17	2	1.5
18 – 20	7	5.2
21 – 23	1	0.7
24 – 26	0	0.0
27 – 29	0	0.0
30 – 32	2	1.5
No Reply	3	2.2

Ninety-one per cent of advanced biology teachers have at least five years of teaching experience. The mean number of years experience was found to be 18.8 with a range from two to forty-four years.

Ninety-eight teachers representing 72.6 per cent of the 135 surveyed reported belonging to a science or science teaching organization. Nineteen such organizations were reported, the National Association of Biology Teachers and the National Science Teachers Association being the most popular.

The data would indicate that most advanced biology courses are taught by teachers who are experienced, well-prepared, professionally minded, and possessing much up-to-date information in the field of biology.

VII. *Course Content*

No status study of advanced biology would be complete without an investigation into the course content. Teachers are interested in what general and what specific subjects are included in the courses of study; what subjects are considered to have been adequately studied in prerequisite general biology; and, what emphasis is placed by the teacher on the subjects that are included in the course.

An investigation into course content is valuable for another reason. Although a course may carry the title of advanced biology and use a college level general biology textbook, in reality it may, for example, emphasize human physiology and anatomy and exclude other areas of biological importance. By obtaining information on the subjects comprehensively studied, it is possible to develop a better understanding of the course content.

Teachers were requested to respond to nine general content sections containing a total of sixty-nine specific subject items. A check list of the subject items was so prepared that the teacher could check one of four responses to each item. The four responses were:

A. The subject is presumed to have been adequately studied in the first biology course and, though possibly discussed, is not enlarged upon in advanced biology.
B. The subject is mentioned and/or defined

TABLE 7

Degree to Which Cellular Structures and Functions Are Studied in Advanced Biology

Subject-Matter Item	Type, Frequency, and Per Cent of Response							
	A	%	B	%	C	%	D	%
1. Nature of cell membrane porosity	20	14.8	44	32.6	63	46.6	8	6.0
2. Nature of cell membrane permeability	23	17.0	32	23.7	77	56.9	3	2.2
3. Nature of diffusion, dialysis, osmosis	30	22.2	24	17.7	78	57.6	3	2.2
4. Nature of solutions in protoplasm	18	13.3	51	37.7	55	40.8	11	8.1
5. Nature of suspensions in protoplasm	19	14.0	51	37.7	53	39.2	12	9.0
6. Nature of emulsions in protoplasm	15	11.1	53	39.2	53	39.2	14	10.4
7. Nature of colloids in protoplasm	14	10.4	52	38.5	56	41.5	13	10.0
8. Nature of the mitochondria	8	6.0	56	41.5	52	38.5	19	14.0
9. Nature of plastids and vacuoles	14	10.4	52	38.5	61	45.2	8	6.0
Total	161	119.2	415	307.1	548	405.5	91	67.9
Mean	13.2		34.1		45.1		7.5	

TABLE 8

The Degree to Which Biochemistry of Nucleic Acids and Cell Metabolism Are Studied in Advanced Biology

Subject-Matter Item	Type, Frequency, and Per Cent of Response							
	A	%	B	%	C	%	D	%
1. The nature of ribonucleic acid	3	2.2	45	33.3	56	41.5	31	23.0
2. The nature of desoxyribonucleic acid	3	2.2	44	32.6	58	43.0	30	22.2
3. The nature of oxidative enzymes	4	3.0	54	40.0	53	39.2	24	17.7
4. The nature of the citric acid cycle	4	3.0	51	37.7	35	26.0	45	33.3
5. The nature of adenosine triphosphate	7	5.2	37	27.4	54	40.0	37	27.4
Total	21	15.6	231	171.0	256	189.7	167	123.6
Mean	3.1		34.2		37.9		24.7	

but no comprehensive study of it is made in advanced biology.

C. A comprehensive study of the subject is made in advanced biology.

D. The subject is not studied in advanced biology.

The per cent of response for each item was calculated. By totaling the per cent response for all items in each section and finding the arithmetic mean, it was possible to compute a mean per cent of emphasis accorded to each content section.

Basic to a study of biology is a knowledge of the cell. Winchester has said of the cell, "Here lies the key to an understanding of the complex problems of heredity, growth, reproduction, embryology, and physiology." (12) Table 7 shows that 45.1 per cent of advanced biology teachers undertake what they believe to be a comprehensive study of cell structure and function. In an additional 34.1 per cent of courses this content section on cells is merely mentioned and/or defined.

Table 8 shows the results of an inquiry on cell biochemistry. Although Weisz (13) has stated that teachers can no longer afford to be silent about DNA or molecular details of respiration, it is apparent that only slightly over one-third of advanced biology courses include a comprehensive study of this topic. In one-fourth of courses the subject is entirely omitted.

TABLE 9

The Degree to Which Types of Cell Division and Resultant Cellular Growth Are Studied

Subject-Matter Item	Type, Frequency, and Per Cent of Response							
	A	%	B	%	C	%	D	%
1. Nature of the centrioles	12	9.0	55	40.8	58	43.0	10	7.4
2. Action of cellular chromatin	10	7.4	38	28.2	81	59.8	6	4.4
3. Nature of cellular mitosis	11	8.1	6	4.4	118	87.4	0	0.0
4. The nature of cellular meiosis	11	8.1	6	4.4	118	87.4	0	0.0
5. The process of fertilization	15	11.1	12	9.0	108	79.9	0	0.0
6. The process of zygotic cleavage	15	11.1	12	9.0	108	79.9	0	0.0
7. Germ layer development and derivatives	7	5.2	25	18.5	97	71.8	6	4.4
8. Development in the chick embryo	7	5.2	46	34.1	64	47.4	18	13.3
Total	88	65.2	200	148.4	752	556.6	40	29.5
Mean	8.1		18.5		69.6		3.7	

TABLE 10

The Degree to Which Structure, Function, and Classification of Lower Plants Are Studied

Subject-Matter Item	Type, Frequency, and Per Cent of Response							
	A	%	B	%	C	%	D	%
1. Evolution of structure in algae	27	20.0	35	26.0	36	26.6	37	27.4
2. Evolution of reproduction in algae	29	21.5	37	27.4	37	27.4	32	23.7
3. Structure and function of the fungi	36	26.6	29	21.5	57	42.2	13	10.0
4. Study of the O, C, and N cycles	56	41.5	24	17.7	52	38.5	3	2.2
5. Study of the nature of viruses	23	17.0	45	33.3	57	42.2	10	7.4
6. Life cycle of moss or liverwort	55	40.8	18	13.3	46	34.1	16	12.0
7. Life cycle of the club moss or fern	55	40.8	19	14.0	46	34.1	15	11.1
Total	281	208.2	207	153.2	331	245.1	126	93.8
Mean	29.7		21.9		35.0		13.3	

The content section on fertilization and embryological growth, Table 9, is extensively studied in 70 per cent of courses, omitted in less than 4 per cent and is considered to have been adequately studied in general biology by 8.1 per cent of advanced biology teachers.

Subjects of a botanical nature are listed in Tables 10 and 11. It is apparent that 35 per cent of advanced biology courses include a comprehensive study of the structure, function, and classification of nonvascular plants. Thirty-six per cent of courses carry out a similar study on vascular plants, according to Table 11.

Tables 12 and 13 show the results of the investigation of fourteen different subjects related to invertebrate animal phyla. The number of teachers considering these subjects to be adequately treated in the first biology course are approximately equal to those who undertake an extensive study of them in advanced biology.

The subjects most universally accorded an extensive study in the 135 advanced biology courses surveyed were the major vertebrate systems. Table 14 lists nine systems found in vertebrates and the emphasis given to them. In eight out of ten courses the students undertake a comprehensive study

TABLE 11

The Degree to Which Structure, Function, and Classification of Higher Plants Are Studied

Subject-Matter Item	Type, Frequency, and Per Cent of Response							
	A	%	B	%	C	%	D	%
1. Life cycle of a flowering plant	74	54.8	8	6.0	47	34.8	6	4.4
2. Nature of flowers and fruits	70	51.8	8	6.0	48	35.5	9	6.6
3. The structural nature of seeds	70	51.8	8	6.0	48	35.5	9	6.6
4. The anatomy of vascular plants	51	37.7	16	12.0	58	43.0	10	7.4
5. Forms of vegetative reproduction	19	14.0	62	45.9	47	34.8	7	5.2
6. The nature of photosynthesis	46	34.1	11	8.1	75	55.5	3	2.2
7. Economic importance of plants	28	20.8	70	51.8	25	18.5	12	9.0
8. Evolutionary significance of plants	37	27.4	37	27.4	48	35.5	13	10.0
Total	395	292.4	220	163.2	396	293.1	69	51.4
Mean	36.6		20.3		36.6		6.4	

TABLE 12

The Degree to Which Structural Development in Protozoa, Coelenterata, and Platyhelminthes Is Studied

Subject-Matter Item	Type, Frequency, and Per Cent of Response							
	A	%	B	%	C	%	D	%
1. Cell structure diversity in Protozoa	43	31.8	13	10.0	76	56.3	3	2.2
2. Freeliving vs. parasitic Protozoa	39	29.0	29	21.5	56	41.5	11	8.1
3. Tissue organization in Coelenterata	57	42.2	24	17.7	49	36.3	5	3.7
4. Alternation of generation in Coelenterata	57	42.2	26	19.3	45	33.3	7	5.2
5. Regeneration in the Coelenterata	56	41.5	31	23.0	43	31.8	5	3.7
6. Mesoderm derivatives in Platyhelminthes	50	37.0	28	20.8	45	33.3	12	9.0
7. Bilateral symmetry in Platyhelminthes	53	39.2	26	19.3	50	37.0	6	4.4
8. Cephalization in the Platyhelminthes	46	34.1	30	22.2	35	26.0	24	17.7
9. Freeliving vs. parasitic Platyhelminthes	53	39.2	30	22.2	48	35.5	4	3.0
Total	454	336.2	237	176.0	447	331.0	77	57.0
Mean	37.3		19.5		36.8		6.3	

of these systems. In an additional 6.0 per cent of courses they are merely mentioned.

Table 15 gives a list of subject items that were included under the content section on heredity. It is evident that this topic also receives favorable treatment in advanced biology; 90.3 per cent of courses either accord heredity an extensive study or at least mention and/or define many terms related to the subject.

Table 16 lists additional subjects that are given an extensive study. This includes such diverse topics as space biology, anthropology, geology, and psychological problems.

"Biology" is defined as the science of life; i.e., the study of the origin, development, structure, function, distribution, and importance of all plants and animals. It is apparent in reviewing the mean per cent of emphasis in Tables 7 through 15 that some advanced biology courses are excluding several content areas of biology from extensive study. As a result, the author feels that some of the courses are misnamed. If secondary schools offer courses with the titles and prerequisites stated at the beginning of this article, such courses should give consideration to a comprehensive study of cells; of the structure,

TABLE 13

The Degree to Which Structural Development in Annelida and Arthropoda Are Studied

Subject-Matter Item	Type, Frequency, and Per Cent of Response							
	A	%	B	%	C	%	D	%
1. Appearance of the coelom in Annelida	55	40.8	16	12.0	58	43.0	6	4.4
2. Segmentation in the Annelida	51	37.7	16	12.0	61	45.2	7	5.2
3. Serial homology in Arthropoda	49	36.6	26	19.3	50	37.0	10	7.4
4. Life cycles in the Arthropoda	61	45.2	23	17.0	45	33.3	6	4.4
5. Social organization in Arthropoda	64	47.4	30	22.2	32	23.7	9	6.6
Total	280	207.7	111	82.5	246	182.2	38	28.0
Mean	41.5		16.4		36.5		5.6	

TABLE 14

The Degree to Which Major Vertebrate Systems Are Studied in Advanced Biology

Subject-Matter Item	Type, Frequency, and Per Cent of Response							
	A	%	B	%	C	%	D	%
1. The vertebrate digestive system	16	12.0	6	4.4	111	82.2	2	1.5
2. The vertebrate respiratory system	17	12.6	6	4.4	110	81.4	2	1.5
3. The vertebrate circulatory system	16	12.0	6	4.4	111	82.2	2	1.5
4. The vertebrate excretory system	16	12.0	7	5.2	110	81.4	2	1.5
5. The vertebrate reproductive system	15	11.1	9	6.6	111	82.2	0	0.0
6. The vertebrate nervous system	15	11.1	10	7.4	110	81.4	0	0.0
7. The vertebrate endocrine system	15	11.1	10	7.4	110	81.4	0	0.0
8. The vertebrate skeletal system	16	12.0	7	5.2	110	81.4	2	1.5
9. The vertebrate muscular system	17	12.6	12	9.0	104	77.0	2	1.5
Total	143	106.5	73	54.0	987	730.6	12	9.0
Mean	11.8		6.0		81.2		0.9	

function, and classification of nonvascular and vascular plants, invertebrate phyla, and vertebrate systems; of genetics; of evolution; of ecology; and simplified explanations of recent and vital biochemical aspects of living systems. If not, then the course should carry a title indicative of the content.

VIII. *Concluding Statement*

Advanced biology courses are appearing more and more frequently in the science curricula of large secondary schools. They are being taught by well-prepared teachers using excellent textbooks. In most courses, the major areas of biology are included in the subject matter content. A wide range of opportunity for the student is offered via reference texts, resource periodicals, individual and group research projects, and laboratory experiences.

Suggestions for changing the present status were given for consideration. These included statements relative to the Advanced Placement Program, course prerequisites, scheduling of classes, course subject matter content, and course nomenclature.

BIBLIOGRAPHY

1. Martin, W. Edgar. *The Teaching of General Biology in the Public High Schools of the United States,* Office of Education Bulletin 1952, No. 9, U. S. Government Printing Office, Washington, D. C., p. 4.
2. Lightner, Jerry P. Advanced Biological Science In Large Secondary Schools, *The American*

TABLE 15

The Degree to Which Genetics Is Studied in Advanced Biology

Subject-Matter Item	Type, Frequency, and Per Cent of Response							
	A	%	B	%	C	%	D	%
1. Mendel's historic genetic work	19	14.0	22	16.4	93	68.9	1	0.7
2. Nature of chromosomes and genes	8	6.0	10	7.4	117	86.6	0	0.0
3. The nature of alleles	8	6.0	22	16.4	98	72.6	7	5.2
4. The nature of linkage	6	4.4	22	16.4	99	73.3	8	6.0
5. The nature of crossing over	6	4.4	27	20.0	95	70.4	7	5.2
6. The nature of lethal genes	7	5.2	27	20.0	94	69.6	7	5.2
7. Nature of sex determination	12	9.0	19	14.0	102	75.5	2	1.5
8. The nature of mutations	8	6.0	19	14.0	106	78.5	2	1.5
9. Significance of genetics in evolution	7	5.2	26	19.3	100	74.0	2	1.5
Total	81	60.2	194	143.9	904	669.4	36	26.8
Mean	6.6		15.9		74.4		2.9	

TABLE 16

Additional Subject-Matter Items Receiving Comprehensive Study in Advanced Biology

Subject-Matter Item	Frequency	Per Cent
1. Theory on origin of life	65	48.1
2. Ecological problems	53	39.2
3. Study of Mollusca	45	33.3
4. Study of Nematoda	43	31.8
5. Study of Echinodermata	41	30.4
6. Living vs. nonliving matter	39	29.0
7. Disease prevention	33	24.4
8. Problems of conservation	24	17.7
9. Bacteriology	13	10.0
10. Radiation biology	13	10.0
11. Microbiology	9	6.6
12. Study of evolution	8	6.0
13. Review of biochemistry	8	6.0
14. Field biology	7	5.2
15. Psychological problems	5	3.7
16. History of biology	5	3.7
17. Paleontology	3	2.2
18. Geology	3	2.2
19. Space Biology	3	2.2
20. Anthropology	1	0.7

Biology Teacher, Vol. 22, No. 4, April, 1960, pp. 226-227.

3. Fordyce, Phillip R. The Advanced Biology Course, *The American Biology Teacher,* Vol. 21, No. 5, May, 1959, p. 168.
4. Kastrinos, William. An Advanced Biology Course In High School, *The American Biology Teacher,* Vol. 19, No. 6, October, 1957, p. 186.
5. Heiss, Elwood D., Obourn, Ellsworth S., and Hoffman, Charles W. *Modern Science Teaching,* The Macmillan Company, New York, 1950, p. 66.
6. Thurber, Walter A. and Collette, Alfred T. *Teaching Science in Today's Secondary Schools,* Allyn and Bacon, Inc., Boston, 1959, p. 382.
7. Frankel, Edward. The Advanced Placement Program In Biology, *The American Biology Teacher,* Vol. 21, No. 8, December, 1959, p. 354.
8. Fordyce, *op. cit.,* p. 169.
9. Silber, Robert. New Vistas in Science Research, *The Science Teacher,* Vol. 24, No. 8, December, 1957, p. 388.
10. Snyder, Naomi M. Honor Biology, *The American Biology Teacher,* Vol. 22, No. 2, February, 1960, p. 89.
11. Conant, James B. *The American High School Today,* McGraw-Hill Book Company, Inc., New York, 1959, p. 39.
12. Winchester, A. M. *Biology and Its Relation to Mankind,* D. Van Nostrand Company, Inc., Princeton, 1957, p. 22.
13. Weisz, Paul B. *The Science of Biology,* McGraw-Hill Book Company, Inc., New York, 1959, preface.

New Bibliography

The *1960 Supplement to Selected Science Books for Secondary Schools* has been prepared by the Connecticut Science Teachers Association and is available from them at 35 cents a copy. It lists 165 titles, and these are in addition to the 525 included in the original bibliography of 1958. Copies may be obtained from Prof. R. Vincent Cash, Central Connecticut State College, New Britain, Connecticut.

An Advanced Studies Program in Biology

EDWARD FRANKEL

Bureau of Educational Research, Board of Education of the City of New York

"Summertime, and the living is easy"—were just words to a popular song to thousands of high school students and high school teachers during the summer vacations of 1959 and 1960. Scores of colleges, universities, secondary schools, and research institutions from Maine to California were alive with an unprecedented number of bright, eager high school youngsters engaged in advanced academic studies and in scientific research. At the same time hundreds of high school teachers attended summer institutes where they grappled with new ideas in content and methodology designed to up-grade and modernize the nation's secondary schools.

The Advanced Studies Program

Among these efforts to upgrade American secondary education was the Advanced Studies Program at St. Paul's School in Concord, New Hampshire. The purposes of the A.S.P., now in its third year, are: first, to provide talented high school students with challenging educational experiences otherwise unavailable to them; second, to interest potential secondary school teachers in the teaching profession; third, to provide secondary school teachers with classroom training in the instruction of the very able student.[1]

The Program, which is directed by Mr. Alan N. Hall with the able assistance of Mr. R. Philip Hugny, has been made possible by a grant from the Fund For The Advancement Of Education. The Program is a resident summer school at St. Paul's School available to boys of superior academic ability from New Hampshire public and parochial high schools and public academies. Approximately 125 boys attended the 1959 Program and enrolled in one of the twelve courses offered for a period of six weeks, six days a week, for a minimum of twenty-one hours a week. In addition, all students were required to study English three hours a week.

The students were selected on the basis of aptitude tests, scholastic achievement, recommendations of the principal and teachers, and interview with the A.S.P. staff.

The Biology Course

The purpose of this article is to describe and evaluate the course in biology which was introduced and taught by the writer during the 1959 Summer Session of the A.S.P. at St. Paul's School.

The course was entirely at the college level. The curriculum was based largely on the experiences and investigations[2] of the writer in developing and teaching an Advanced Placement Program course in biology over the past six years at the Bronx High School of Science.[3] The class consisted of nine boys; eight were entering their senior year, and one had been graduated from high school and is now attending Dartmouth College. All had completed a course in elementary biology, and six had also studied high school chemistry. The teacher was assisted by two interns, an experienced secondary school teacher, and a young man who was preparing to enter teaching as a profession. As previously indicated, the group met six times a week for 21 scheduled hours, a total of 126 hours.

Planning Criteria

Preliminary planning indicated that it would be administratively possible to complete the equivalent of a year's college work within the assigned time. However, an experimental program of "superaccelerated" study, that is, a course for high school students in which approximately a week's work is covered in a day, posed a number of very important problems in curriculum planning. How would the students react to "superacceleration?" To what extent could the teacher as well as the students maintain this pace? Without attempt-

[1]*The Advanced Studies Program—The 1960 Catalog;* St. Paul's School, Concord, New Hampshire.

[2]Frankel, Edward. "A Comparative Study of Achieving and Underachieving High School Boys of High Intellectual Ability," *Journal of Educational Research.* 53:25, 172-180, Jan. 1960.

[3]Frankel, Edward, "The Advanced Placement Program," *The American Biology Teacher.* 21:8, 351-358, Dec. 1959.

ing to evaluate the educational and psychological justification or desirability of superacceleration, which in itself represents a fertile field of research, a flexible experimental approach in planning the program was indicated.

In planning the course content and appropriate pedogogical procedures, special consideration was given to the following:

(a) diversification of daily activities designed to minimize fatigue and to maintain interest: field trips, lecture demonstrations, and special laboratory exercises were planned to enrich and vitalize the course content.

(b) provision for individual differences in ability, interest, background preparation, and application by providing optional laboratory exercises, reading references, and field collection trips.

(c) a program of daily and weekly evaluation.

(d) a flexible lecture and laboratory schedule to allow for the "unexpected," a predictable constant in an experimental program.

Course Content

In the program of study followed, lecture and laboratory work each received about equal time daily. The lectures and laboratory exercises emphasized fundamental modern biological principles applicable to both plants and animals. Evolution was the dominant and integrating theme; constant reference to functional morphology related this theme to the laboratory experiences of the students. The major theme of the lectures in the first three weeks was biochemical evolution of life, biochemical and biophysical aspects of protoplasm, biochemistry of photosynthesis and metabolism, and comparative plant and animal physiology. The second three weeks concentrated on organic evolution and stressed reproduction, genetics, embryology, and mechanisms of evolution.

The laboratory exercises dealt with the study of representative organisms of the principal plant and animal phyla. A unique feature of the laboratory work was that most of the organisms studied were collected by the students themselves. Pond water samples from the many lakes and ponds in the area of St. Paul's were collected and maintained by the individual students. These cultures provided bacteria, protozoa, algae, hydra, planaria, worms, and crustacea.

The ponds supplied also frogs and crawfish for the more agile students. The spacious school grounds yielded an abundant supply of night crawlers, liverworts, mosses, ferns, evergreens, and flowering plants. Needless to say, students were most enthusiastic about their "hand picked" specimens, particularly the frogs, crayfish, and earthworms. These collection expeditions proved so popular that the students suggested that a course in field biology become part of the Advanced Studies Program in the future.

In addition to the student collected specimens, commercially purchased and teacher collected materials were made available. Students worked with fruit fly cultures, 48-hour living chick embryos, preserved grasshoppers, injected frogs and rats, and living rats—males and females, some of the latter pregnant.

Each student was supplied with a triple objective microscope, a set of prepared microscopic laboratory slides, separate laboratory specimens, a set of biological stains, a dissection pan and dissecting instruments, and a slide box containing slides, cover glasses, lens paper, and the like. This equipment made it possible for a student to do his individualized laboratory work at his own pace. As the session progressed, students developed a greater proficiency in general laboratory procedures, in the use of the microscope, and in dissection techniques. They worked more quickly and efficiently. More and more frequently students began to spend their "free" afternoons and evenings in the laboratory completing assigned work, studying an organism more intensively than routine assignments required, or doing advanced work. It was not uncommon to find students in the laboratory "burning the midnight oil" until curfew.

Required Reading

In addition to textbook assignments in *Life*, by Simpson, the class was required to read Harvey's, "The Motion of the Heart and Blood," and Mendel's "Experiments in Plant Hybridization," and to write critical evaluations of these papers in the light of their historical importance. *Scientific American*, *Great Experiments in Biology*, by Gabriel and

Fogel, and *Biology*, by Weisz were used for optional and supplementary reading. Despite the lack of time and the pressure of the required work, most of the students availed themselves of these references.

Field Trips

Most stimulating and enjoyable were the three field trips made by the entire class. These excursions provided a change of pace and scenery as well as recreation. The trips were planned for Wednesday afternoon, a "free" period, and so no time was lost from instruction or study. The first trip to Mount Kearsage had two objectives: first, to collect and study plants in a broad variety of ecological situations, and second, to climb to the top of Mount Kearsage and there consume a sumptuous picnic lunch. Both objectives were "taken" with great enthusiasm.

The second trip was to the Agricultural Experimental Station of the University of New Hampshire at Durham where the director, Dr. Harry A. Keener, personally arranged a tour and conducted the group. Current research in light effects on weed-killers, in bee culture and breeding, and in plant breeding were presented by Dr. Stewart Dunn, Dr. William Lee, and Dr. Elwyn Meador, respectively. The group met these scientists personally, talked with them, and had an opportunity to see research in progress. These experiences gave these boys some familiarity with their own State University and its facilities for biological study and research.

The third and last trip was to the clinical laboratories of nearby Concord Hospital. Here the Chief Pathologist and Chief Technician demonstrated apparatus and procedures employed in hematology, urinalysis, serology, blood chemistry, and pathology.

Testing Techniques

A very effective testing instrument for measuring a student's ability to make critical evaluations, to express comparisons, and to trace relationships is the essay type examination. Years of experience with college-level biology classes have convinced the writer that one of the most difficult techniques for students to learn is how to write an essay that is acceptable from the point of view both of content and of written English.

An effective method for helping students gain experience and skill in answering essay questions is constant practice writing followed by conferences analyzing the answers. The weekly tests administered to the class were exclusively of the essay type; the questions were frequently drawn from previous Advanced Placement Examinations in Biology since these questions are representative of the depth and scope of college level work. It was satisfying to find that most of the boys developed proficiency in their ability to handle these questions.

Laboratory exercises were evaluated and graded daily. There was frequent testing with commercially prepared laboratory quiz sheets, essay questions, and "practicums." The latter technique consists of setting questions based on a series of demonstrations of materials studied in the laboratory, living and preserved specimens and microscopic preparations. Next to each demonstration is a card setting three or four questions related to the particular set-up; the student answers these in writing in one or two minutes. He then moves on to the next demonstration and repeats the procedure. For most of the students, this type of examination was a novelty to which they reacted very favorably; they said they enjoyed the experience.

Evaluation—Student Reactions

Since the course was experimental in nature, an attempt was made to evaluate it in terms of student reactions by means of a questionnaire prepared by the writer. The following is a summary of some of the significant responses of the boys and the two interns to the various aspects of the course:

1. Laboratory work: The most popular and best liked exercise was the study of living rat. In general the boys found the study of animals more interesting and challenging than the study of plants. The time allotted for laboratory work was considered adequate, the method for checking and evaluating the laboratory work effective and desirable; there was an adequate supply of laboratory materials. There was unanimous agreement that the laboratory work was very rewarding and tremendously stimulating.
2. Lecture: The topics found most interesting here were genetics, cytology, and evo-

lution. These areas, it appears, had either been omitted or covered only very superficially in the elementary biology courses. Most of the boys were fascinated by the biochemistry of photosynthesis and metabolism.

3. Out-of-Class Activities: All students agreed that they had developed more effective study habits.
4. General Evaluation:
   A. Biology Course: There was unanimous agreement that the course should be offered again. Some of the reasons cited were:
   "It is an excellent discipline, thoroughly stimulating to intellectual curiosity. Gave me a tremendous boost in enthusiasm."
   "It is thought provoking and stimulating. I now look for relationships in everything."
   "It opened up new ideas and provoked thinking."
   "It helped me decide my future, gained better study habits, and prepared me for college."
   "It showed me where my interests are and what my capabilities are."
   B. Entire Program
   The aspects of the A.S.P. beyond the classes and study periods which contributed most to academic progress and intellectual growth were (1) the accessibility of a library (2) the exchange of ideas with other students and with the teachers and (3) the general atmosphere of the Program. A few students pointed out that lack of time deprived them of the opportunity to utilize the library facilities as fully as they would have wished.

In an unsolicited letter written six months after the conclusion of the course, a student offered the following evaluation of the A.S.P. experience:

> "The effects of the ASP on my school work are incalculable. Even though I carried my heaviest burden of extra-curricular activities this year, there has been no appreciable dip in my marks. I was the highest Senior for the first quarter with an average of 96 per cent. I can only account for this on the premise that I must have acquired three qualities at St. Paul's: (1) stamina, (2) ability to organize my time to the best possible advantage, and (3) good study habits. Also, my powers of concentration have been greatly improved. The facets of the ASP that especially appealed to me were the quality and college-level work required of the students, the latitude one was afforded in study habits and the incentive I developed to become independent and self-responsible. I am sure that the Program had a maturing effect on me, and gave me a proper outlook on studies in general. In summation, the ASP was an exciting and rewarding adventure. As Mayor James Curley once said, "I'd do it again!"

Student Achievement

Every student in the class completed the course and received a final grade of "Satisfactory"; three students were graded "Superior." At the suggestion of the Program, all the students took the August 1959 Achievement College Entrance Examination in Biology. The scores ranged from 608 to 787 with the mean at 710.9. It was interesting to note that the three boys who were graded "Superior" received the top scores on the Biology achievement test 787, 769, and 746, respectively.

Teacher Evaluation

No evaluation of the ASP in Biology would be complete without acknowledging the enthusiastic cooperation and indefatigable efforts of the Program Director and his Assistant in providing ideal conditions for teaching a college level class. Not only did they make available all the necessary materials and services, but also they selected a group of highly motivated and dedicated boys, as well as interns. Whatever success was achieved must in part be attributed to the "pedogogue's paradise" which they helped to create.

If student reactions are regarded as one of the criteria for judging the success or failure of the course, it appears that the original purpose of ASP was realized, namely, to provide able students with educationally challenging experiences. Furthermore, there is evidence that some of the students are applying the more effective habits of work acquired to their regular school work.

Admittedly, the pace, the scope of the work, and the high standard of performance expected were most demanding, and at times even the most capable students faltered briefly; the teacher also had his bad moments. Apparently enough drive had been generated to enable the boys to clear the rough spots and emerge at the finishing line. The August

Biology Achievement test results seemed to indicate a positive correlation with performance in the course; the same boys turned in top grades in both.

With respect to course content, the writer finds himself in agreement with student opinion as regards laboratory work. The popularity of collection trips indicated that they should be continued and exploited more thoroughly. The lecture topics require rethinking since it was in this area that the students found their greatest difficulty.

Finally, the writer too, believes that the course should be continued. To quote a quote "I'd do it again!"

The Response of Paramecia to Electricity

FRANK E. WOLF
Fitchburg State College, Fitchburg, Massachusetts

Introduction

Galvanotropism may be demonstrated in several ways. One method utilizes a paraffin trough described in Miller and Blaydes.[1] Another method utilizes a glass U-tube and a microscope; this method is suitable for projecting but not for individual work. A third method utilizes a hanging drop slide. A fourth and original method described here involves somewhat greater work in the preparation of a chamber but is suitable for both projecting and individual microscope study.

Materials

Student microscope, preferably with mechanical stage; paramecia culture; eye droppers; one and one-half volt dry cell; glacial acetic acid; copper wire; Lucite blanks cut to slide size, approximately 1 x 3 inches, and one-eighth to one-fourth inches thick.

Preparation

For each chamber to be made, two Lucite blanks are needed. One blank is used as the bottom base of the chamber; the other blank is drilled and sawed to form a container for the culture. Drill a half-inch hole through the center of the top blank. Using a cross-cut saw, scar the surface of the top blank across the long dimension to hold the copper wire.[2] Insert the wires and seal with Duco or Elmer's Glue-All. Bond the two blanks together, using glacial acetic acid, with the scar against the bottom blank.

[1]Miller, David, and Blaydes, Glenn, *Methods and Materials for Teaching Biological Sciences.* McGraw-Hill Book Company, Inc., New York, 1938, pp. 364-5.

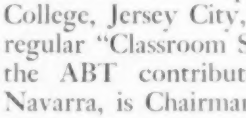
[2]Holes may be drilled from both ends of the top slide to the central chamber to contain the electrodes.

Procedure

1. Attach the outside ends of the wires to the dry cell.
2. Fill the chamber with paramecium culture.
3. Observe under the low power of the microscope.
4. The protozoa will be seen gathering at the negative electrode.
5. Reverse the poles at the battery.
6. The animals will be seen to move to the opposite side of the chamber.

Discussion

Note that this chamber is designed to keep the wire electrodes under control. An easier procedure utilizes a culture on a concavity slide with the wires placed on top of the slide. This loose arrangement of the wires presents problems, however, which are overcome by the use of the described plastic chamber.



1. HALF INCH HOLE
2. CROSS-CUT SCAR

Science Activities Bulletin

The Science Department of Jersey City College, Jersey City, New Jersey, publishes a regular "Classroom Science Bulletin." One of the ABT contributors, Professor John G. Navarra, is Chairman of the Science Department and may be addressed for copies of the bulletin. The October, 1960, issue tells something about the science curriculum at the College and also includes an excellent article on how to teach genetics by Dr. Ruth Dugan.

Outline for a High School Second Year Biology Course

GEORGE C. TURNER
Orange County State College, Fullerton, California

How many times have we, as biology teachers, been torn between going on to "the next topic," or continuing a particular phase of the course which interests only a few students? Many plans for group activities and modified "contract" methods have been suggested to overcome this dilemma. However, the demands of teaching two or three groups in one class period may prove too much for many a conscientious teacher.

The following description of a second-year biology honors course provides what the author has found to be a stimulating way of meeting this dilemma. It was conceived during those class discussions which constantly crop up when a vital chord is struck. The discussion leaders, continually being cut short so that the "majority" would not become bored, began seriously proposing the continuation of the course into a second year. Following up on these requests, interested students spent many afternoons and evenings with the teacher discussing what *they* wanted out of such a class. The results of these conferences led to the statement of three general objectives which have guided the classwork ever since:

1) To explore areas in the field of biology which are of particular interest to the members of this class.
2) To learn techniques and the use of equipment commonly used in biological research.
3) To allow each student to carry out research of special interest to him.

The prospects of such an outline were somewhat frightening to the teacher, whose college and practical training was centered in the field of natural history. However, the challenge was there, and the opportunity to learn along with the students was a facet most intriguing to the class.

With the approval of our Claremont High School curriculum committee, administration, and school board, we launched into the planning stage for the next year's course. I say "we" with emphasis for the teacher's role could be described as: innocent bystander, arbitrator, interpreter of rules and limitations, resource person, and "general flunkie" for an inspired group of people. This stage of our endeavor lasted three months with bi-weekly meetings being the rule. These meetings soon defined the areas to be investigated and included frequent consultations with community resource people. I should add here the remarkably enthusiastic help extended by medical doctors, veterinarians, laboratory technicians, and college professors. This help was generously backed with loans and gifts of equipment, facilities, and even money.

Our initial course work was finally limited to studies in the general area of medicine. It was decided that a colony of laboratory rats should be maintained as the closest parallel we could obtain for our studies of the human body. Consequently, two of the "handymen" of the group volunteered to construct the cages according to our specifications. Six units of four cages each awaited the class the following fall when school commenced. Our parent stock of rats was donated by a local research institution, and we were soon in business with over fifty newborn within the first two months.

Two second year biology students performing an adrenalectomy. Notice simplicity of equipment.

CONTENT	MATERIALS	PROCEDURE
I. Animal care and maintenance A. Instruction and practice in caring for laboratory animals (one week)	1. Cages–24 2. Rats–50 3. Large variety of instruments and materials used in maintaining a rat colony. 4. Texts–*The Rat in Laboratory Investigations*, Farris and Griffith. Assorted pamphlets on laboratory animal care	1. Cages planned and built by students 2. Students perform all duties involved in maintaining the colony 3. "Duty roster" developed for distributing responsibilities
II. Anatomy of the rat and man A. Embalming procedures for anatomy studies (two days)	1. Chemicals and equipment necessary for preserving specimens 2. Texts: *Teaching High School Science: A Sourcebook for the Biological Sciences,* Morholt, Brandwein, and Joseph	1. Students chloroform necessary specimens 2. Students prepare embalming fluid and carry out process
B. Systematic study of anatomy 1. Practical and theoretical (seven weeks)	1. Dissecting kits and associated equipment for dissection 2. Various college laboratory manuals on zoology 3. Text: *The Human Organism*, DeCoursey	1. Students paired to dissect animals 2. Reports, discussions, and lectures on various systems of the rat and human organisms
III. Special techniques A. Preservation of skins and skeletons 1. Skins preserved soon after animals chloroformed 2. Skeletons preserved after anatomy study and from newborn	1. Skin preservatives and equipment necessary for this technique 2. Text: *About Mice and Man*, Avis 3. Grunberg and Spalteholtz techniques employed for these two exercises	1. Students preserve skins from their specimens
IV. Blood analysis and urinalysis A. Techniques and reasoning discussed and demonstrated 1. Blood analyses: a. red cell count b. white cell count c. differential count d. hemoglobin analysis e. blood typing 2. Urinalyses: a. color b. odor c. transparency and sedimentation d. acidity e. specific gravity f. albumin content g. mucin h. sugar (four weeks)	1. All chemicals and equipment necessary for carrying out the analyses described 2. Texts: *About Mice and Man*, Avis, and *Clinical Laboratory Methods and Diagnosis*, Gradwohl	1. These techniques are first studied in texts, then discussed and demonstrated. Local medical laboratory technicians and teacher demonstrate 2. Tours and demonstrations of latest techniques in nearby laboratories
B. Techniques practiced by students on: 1. Themselves 2. Laboratory animals (four weeks)	1. Same as above	1. Each student performs each techniques on himself 2. Each laboratory animal is earmarked and given a complete analysis by student caring for it

CONTENT	MATERIALS	PROCEDURE
V. Research techniques A. Various approaches to scientific research studied (two weeks)	1. Text assignments, library research a. Dittoed research guides b. Texts: *How to Do an Experiment*, Goldstein, and *Technical Writing*, Hendricks and Stoddard	1. Reading assignments in texts and scientific journals 2. Reports by students on examples of various methods. Class discussions on these approaches
B. Statistical and mathematical aspects of research studies (one week)	1. Examples of possible research data and how it may be handled	1. Teacher explains various procedures. Students carry out exercises relative to these methods
C. Research proposals submitted, discussed, and work begun on projects (time—four weeks of discussions—research time unlimited, including classtime, after school and week-ends)	1. Proposals worked out by students	1. After detailed discussions among all members of the class, the proposals are revised and filed with the teacher, and student begins project
VI. Surgical techniques A. Basic procedures of surgical techniques discussed and demonstrated 1. Examples: splenectomy, adrenalectomy, transplantation of tissues (two weeks)	1. Surgical instruments and related materials a. Many of these articles are donated by hospitals and physicians 2. Texts: *The Rat in Laboratory Investigations*, Farris and Griffith, *About Mice and Man*, Avis, and *Experimental Surgery*, Markowitz	1. Assignments in texts; class discussions of techniques and effects of surgery 2. Veterinarian, teacher and trained student demonstrate procedures
B. Various elementary operations performed by students on laboratory animals 1. Entire class organized to perform duties necessary during operations (time—four weeks)	1. Appropriate surgical instruments and materials 2. Appropriate apparatus to analyze animal's condition	1. Assignments made for: a. Surgeon b. Assisting surgeon c. Anesthetist d. Two students perform each of the blood and urinalyses described in IV, A, above 2. Follow-up care of animal done by surgeon
VII. Research continued A. Classtime utilized for research B. Second project or continuation of original proposed research (time—remainder of year)	1. As in V. C. above	1. As in V. C. above

Note—Later classes have chosen to investigate subjects such as animal psychology and marine biology in lieu of the second research project

The development of this first year's course, which proved to be so popular that the next class insisted on a similar arrangement, is presented in a general resource unit—with refinements as dictated through student critiques.

The students and teacher are quite aware of the gaps, both in depth and span of coverage, which the limited school year presents. To help overcome this shortcoming, we have had to schedule the class during the last period of the day so the laboratory work and discussions could continue after school hours. At times, evening and week-end sessions have been requested by the students. Although inconvenient at times, the rewards in enthusiasm justify the time spent. When schedules conflicted for these extra sessions, carefully selected resource people from the community volunteered their services.

Two more aspects of the course should be mentioned. One concerns the qualifications for entrance into the class. These were decided as: (1) a "B" or better grade in the college preparatory biology class, (2) obvious interest in science, (3) above average performance on standardized tests concerned with science, mathematics, and English, (4) completed or enrolled in chemistry, (5) instructor's and counselor's recommendations.

The second aspect is that of evaluation of the course. Its continuance as a purely elective course over a period of three years is the first recommendation as meeting the students' needs. Critiques following each year's class have encouraged the instructor and enhanced the course. Student and community acceptance has been substantial. Members of the class have either confirmed their desires for medical careers or definitely decided against them. Two regional awards in the Science Achievement Awards contests, and six places in local science fair competition, have been won by members in the course.

The leeway in subject matter and methods allowed in such "enrichment courses" as this has had a more subtle effect on the student body. They have begun to see useful applications of the compartmentalized, subject-matter program which they have been forced to follow throughout their schooling. This is not meant to imply that teachers do not make a practice of pointing out the transfer aspects of their particular subject matter. Rather, their attempt to put across what is felt to be useful to the range of abilities and interests within a given group of students sometimes bogs down under the sheer weight of these variables. However, when the students have the opportunity to plan their course, have the background, ability, and interest to handle more sophisticated ideas and techniques, then the flowering of past training reveals itself during the exciting hours spent in association with these people.

Student made cages for the rat colony. Urine collector to the left. Duty assignments posted above cages.

Tribolium Guide

A student research team which has received grants totaling $1,200.00 for the study of the genetics of the red flour beetle has written a sixteen-page booklet entitled *Tribolium Guide*. It gives detailed culture information for flour beetles and suggestions for their use in simple inheritance, quantitative inheritance, mutation, ecological, and nutritional studies. Since flour beetles are hardy, breed in flour, and seldom fly, they are useful organisms for classroom and research laboratories and biology projects.

Copies of the guide are available at 15 cents each from the Lyon Science Club, Salem High School, Salem, Indiana. The Club also supplies beetle mutants. Five mutant types with culture instructions are furnished for $1.00. Fourteen mutants are available. Biology teacher, Harold L. Eddleman, is in charge.

Advanced Biology in Summer School

RICHARD K. HAYES
Warwick Veterans Memorial High School, Warwick, Rhode Island

Ecologically speaking, Warwick High School is ideally situated, in that its land borders on a small fresh water pond and is located within a mile of Narragansett Bay. Our environment has been passively challenging us since the school was opened in the fall of 1955. Largely as the result of an intensely stimulating National Science Foundation Institute in marine biology which the writer attended at Bowdoin College in the summer of 1959, plans were made to undertake an ecological analysis of our pond. Plankton nets and dredging equipment were ordered, as well as three stereoscopic microscopes, goggles and gloves, temperature-and-depth meters, and much other lesser equipment.

Equipment began arriving early during the spring. Our plans were to formally initiate the project with our advanced biology students in the fall. Then a new and intriguing opportunity presented itself. We learned that the advanced biology course was to be offered in summer school as a part of a program of enrichment courses proposed by the Superintendent of Schools. This is in accord with recommendation 17 in Conant's *The American High School Today*, as well as with a nationwide trend toward providing elective enrichment courses during the summer for able students. This, we realized, would be the ideal time to get well underway in our pond study. The course would be open to students who had attained an honor grade in first year biology. Credit for one semester of advanced biology would be given. The course would meet for two hours daily, Monday through Friday, for thirty meetings. This compares very closely with the total class time for either a fall or spring semester course. A drawback for a number of students was the fee of $35. This is necessary, however, as according to the regulations of the school department, the summer school must be financially self-sufficient.

With these facts, plus plans for course content, ten-minute talks were given by the writer to each of the classes in the science department. The result was the enrollment of ten students, exactly the minimum required by the school administration. Many more students were prohibited from enrolling only by the fee. With a paid enrollment of five boys and five girls, the course was definitely to be given. More detailed plans were made, including a tentative listing of daily topics and an order for laboratory materials.

Two subject matter units were selected: cytology, because of its basic importance to modern biology, and ecology, in line with our pond study. Approximately thirty class hours were devoted to each area, being divided roughly equally between lecture and discussion on the one hand, and laboratory and field study on the other.

For the unit in cytology the new book, *The Cell*, by Swanson, was selected.[1] This proved adequate as a basic text and was supplemented by the reading of some ten reprints of *Scientific American* articles dealing with aspects of cell biology. This writer considers these reprints of inestimable value in any advanced biology course. Each student was required to write a term paper dealing with a phase of cell biology. Topics chosen included "The Ribosome," "The Mitochondrion," "The Golgi Apparatus," "The Structure of the Chromosome," "Fertilization," and others. This afforded students an opportunity to become familiar with recent technical monographs in cytology. Most of the reading was done at the Biological Sciences Library at Brown University.

Laboratory work in cytology included examination and staining of plant and animal tissues, qualitative analysis of nutrients, observation and experimentation with unicellular forms, and an introduction to the use of the freezing microtome. In connection with our studies of the physiological activity of the gene, a field trip was taken to the genetics laboratories at Brown University.

It was possible to present a completely

[1]Carl P. Swanson, *The Cell*, the first of 11 short texts in the *Foundations of Modern Biology Series*, Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1960.

modern approach to cell biology, largely because of the writer's attendance at an excellent In-Service Institute at Brown University during the school year 1959-60, in which cell research was emphasized. The essential biochemical events in such processes as photosynthesis, cellular respiration, the replication of DNA, and protein synthesis were enthusiastically received and well understood by the students. As their outside reading progressed, the students were able to assist significantly in the lectures in cytlogy. Discussions were lively and at a high level of understanding.

The units in cytology and in ecology were presented concurrently. Sometimes one hour was devoted to each; other times both hours were spent in one of the areas, especially when either field or laboratory work was scheduled. This proved to be a successful approach, as it was possible to link the two areas at many points. Two examples will help to explain this point: (1) diatoms, the most important form of phytoplankton in a pond, were discussed both as to their cytological features and their ecological niche; (2) the light phase of photosynthesis and the significance of light as a factor in a pond ecosystem were integrated.

Our unit in ecology emphasized study in the field and in the laboratory. It was heart-warming to witness the cooperation of people in the community, of other teachers in the department, and of professional biologists. We were offered the use of three rowboats by waterfront residents. Two very profitable collecting trips were made on Narragansett Bay, at the invitation of one of the students and of one of this June's graduates respectively. Field trips were taken to a state trout hatchery and to the Narragansett Marine Laboratory, where excellent programs were arranged for the class. We were invited to make a survey of a pond located on the property of a summer camp for girls, some thirty miles distant from the school. This showed a marked contrast to our own pond, in temperature variation, depth of light penetration, and variety of living forms found.

In order to broaden the students' appreciation of ecosystems we were able to study several salt water environments, including a sandy beach, salt marsh, and tidepools. Each time we went into the field we were equipped with microscopes, collecting jars, and key books. Note: in saltwater collecting it is highly desirable to preserve specimens on the spot!

Lecture work in ecology included a consideration of the importance of such abiotic factors as temperature, light, water and dissolved substances, and topography. Food chains were considered in detail, both as to theory and with reference to chains existing in our little pond. Special attention was given to organisms we collected in the pond. These included diatoms, desmids, blue-green and green algae, protozoa, coelenterates, rotifers, crustaceans, immature insects, and teleost fish.

As the reader might well imagine, such a summer course in biology is largely fun. This does not, and did not mean in our case, that theoretical study in depth need be sacrificed. It seems evident to the writer that more can be accomplished in the summer than during a semester of the regular school year in an advanced biology course, for the following reasons: (1) most of the students are studying only biology, and therefore can concentrate in the one area; (2) with ten hours a week, there is much more continuity and less need to review than during the school year; (3) weather conditions are at their best for field study; (4) interruptions from the office are at a minimum (forms to be completed, telephone messages, intercom announcements, and the like). This course has proven to be a "shot in the arm" to our entire biology program, both to the teachers and to the students. We have heard that the ten students enrolled this summer have been actively encouraging their friends to enroll next summer. This, we feel, will encourage future students who want to have fun and yet make good use of their summer vacations. We have found also that field work *can* be very educational and constitutes *the* ideal way to study biology: by observing organisms in their natural habitats, struggling with the forces of their environment, eating and being eaten. Why not try it in your school? You will be richly rewarded.

Pamphlet

"In Our Forests Are Many Mansions" is a new publication by the Forest Service of the U. S. Department of Agriculture.

A High School Oceanographic Laboratory

KENNETH SHERMAN*

Biological Laboratory, U. S. Bureau of Commercial Fisheries, Honolulu, Hawaii

Introduction

Recently much attention has been focused on the study of oceanography. The first International Oceanographic Congress was held in August, 1959 at the United Nations Building in New York. Approximately 1000 delegates representing 54 nations participated. The National Academy of Sciences recently released its report concerning the great necessity for expanding ocean research. Both of these events received coverage in press releases resulting in numerous newspaper and magazine articles reaching a large part of the world population.

Oceanography is a new frontier of science which will challenge the imagination of any alert student. Problems concerning almost every basic biological and physical concept are present. Here is an environment that presents a great opportunity for original investigation. The physiology, morphology, and ecology of only a small number of marine organisms is now generally understood, particularly those which have little or no commercial importance. There are many gaps in our knowledge concerning the physical properties and biological populations of the world's oceans. An oceanographic laboratory will afford participating students in coastal communities a unique opportunity to become familiar with research methods and problem solving techniques. There is also good indication that a number of these students could conceivably contribute to a better understanding of man's newest frontier, the oceans.

Organization

The methods of organizing a laboratory are varied depending largely upon local conditions. Initially one should probably begin with a small group of students possessing high aptitudes and a genuine curiosity concerning the oceans.

Selection at Randolph High School, Randolph, Massachusetts, was on a competitive basis. Five classes of sophomore biology students were given two lessons concerning the cycle of life in the oceans with particular emphasis on its origin, economic importance, physical features, and untapped resources. The students were then required to complete a report of approximately 1500 words entitled, "The Cycle of Life in the Oceans," using a minimum of three reference books. Students who produced the most comprehensive reports were later interviewed, and from this group ten who showed a genuine curiosity, interest, and aptitude were selected to become staff members of the laboratory.

The students selected were encouraged to familiarize themselves with oceanographic literature which was made available. They discussed their findings at a meeting, at which time it was generally held that while there were a great many excellent problems to work on, many were impractical from the standpoint of available equipment, time, and the difficulty of securing adequate samples. It was decided to begin the studies with readily available local fish species which not only provided interesting problems but also the opportunity to secure valuable scientific data.

Equipment

The high school biology laboratory is an ideal place to center student activity after regularly scheduled classes. Available in most laboratories are work benches, running water, electrical outlets, cabinets, blackboards, and the essential equipment listed below. Very little special equipment need be purchased.

The following list of items were used by students at Randolph High School. Unless otherwise indicated the equipment was available for use in the regularly scheduled biology laboratory sessions.

1. Library
   a. A number of periodicals, scientific reprints and textbooks were purchased or otherwise acquired to provide easy access for essential background literature. See general reference section.

*Formerly biology Instructor at Randolph High School, Randolph, Massachusetts

Figure 1. Several members of the Randolph High School Oceanographic Laboratory Staff at work: (left to right) Fred Hubble and Robert Merritt are examining plankton collected for their productivity studies. George Fahey is busy checking through the literature concerning the distribution of the tomcod, while Peter McGrath is shown grinding down a bone (otolith) taken from the skull in an effort to observe the growth pattern of annual rings similar to those found in a tree. Everett Schaner is examining the gonads as part of his fecundity study of the same fish.

b. Arrangements were made with the Library of the Museum of Comparative Zoology at Harvard to use its reference collection.
c. The laboratory was put on the mailing list for receiving fishery research papers published by the U. S. Bureau of Commercial Fisheries.
d. A catalogue listing available scientific reprints in the laboratory was compiled by students.

2. Audio-visual equipment
   a. 16mm. sound motion picture projector. Excellent motion pictures concerning oceanographic research are available on loan from the University of Miami Marine Laboratory. The U. S. Bureau of Commercial Fisheries also has films available on loan from large university audio-visual centers.
   b. Slide projector
   c. Tape recorder
3. Microscopes
   a. Ten monocular student type with two objectives 10x and 40x.
   b. Five binocular dissecting type with interchangeable eye pieces, of 10x, 20x, and 30x.
   c. Ten microscope lamps.
   d. Microprojector.
4. Dissecting equipment
   a. Thirty dissecting kits containing scalpel with changeable blades, two probes, forceps, scissors, ten cm. rule, and dissecting pins.
   b. Thirty wax bottom dissecting pans.
   c. Three large filleting knives (special purchase).
   d. Two sets of metal tongs for handling preserved specimens.
5. Measuring devices
   a. Three balance scales, maximum weight—150 grams.
   b. Three meter sticks.
   c. One 36 cm. fish measuring board (special construction).
   d. One analytical balance.
   e. One set of calipers, scale 10 cm. in 1 mm. divisions (special purchase).
   f. Thermometer—measuring water temperature.
   g. The laboratory members were allowed use of an analytical balance at the Quincy City Hospital for precise measurements during one of the fecundity studies.
6. Collecting gear
   a. Two fine mesh plankton nets (special purchase).
   b. Fishing lines and assorted tackle (special purchase).
   c. Three metal barrels for storing specimens; refuse type available with covers at most hardware dealers (special purchase).
   d. Ten dozen assorted jars for preserving specimens (special purchase).
   e. Four canvas water buckets (special purchase).
   f. Two small seines (special purchase).
   g. Fish tags and tagging gear were kindly provided on loan from the U. S. Fish and Wildlife Service, Woods Hole, Massachusetts.
   h. Many specimens were collected from cooperative fishermen in the ports of Boston, Hull, and Cohasset.
7. Vessels
   a. The laboratory was allowed the use of a 16 ft., 18 h.p. Thompson runabout which was available for sampling trips.
   b. A number of sampling trips were taken from small rented outboard boats available at various ports along the coast at a cost of approximately two dollars an hour. The expense of renting a vessel was shared equally among the staff members.

Figure 2. Peter McGrath weighing a tomcod as part of his age and growth study.

8. Preserving materials
   a. 15 gallons of formaldehyde for specimens (special purchase).
   b. 5 gallons of isopropyl alcohol for specimens (special purchase).
   Note: Most specimens can be hardened in 10% formalin and then preserved in 30% isopropyl alcohol.
   c. Large ice-cream freezer for freezing and storage of specimens (on loan from local dairy).
9. Chemical supplies (available on loan from chemistry department).
10. Physical science apparatus (available on loan from physics department).
11. Office supplies including typewriters and duplicating materials (available from school business training department).
12. Woodworking supplies (available from woodworking department).
13. Heavy machinery (limited supply available from school auto-shop department).

Selection of Projects

The selection of research projects depends largely on availability of equipment, time, the opportunity for adequate sampling of organisms, and environmental variables.

Numerous projects worthy of short term investigations are present in the nearshore marine environment. The following list contains titles and brief descriptions of projects initiated by students at Randolph High School. Also included are some suggested projects for study. One need only to browse through the many scientific periodicals concerned with marine investigations to realize the varied research now in progress involving the biology, chemistry, and physics of the oceans. The following list is far from complete and

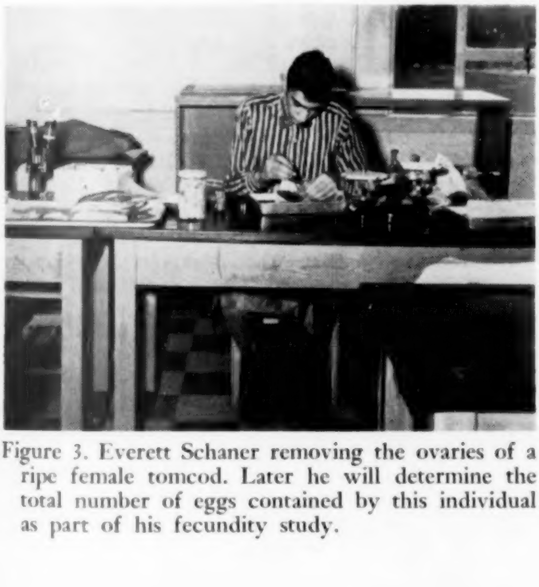


Figure 3. Everett Schaner removing the ovaries of a ripe female tomcod. Later he will determine the total number of eggs contained by this individual as part of his fecundity study.

Figure 4. Fred Hubble and Robert Merritt examine samples of plankton taken from surface tows off the coast of Hull Bay, Massachusetts. George Fahey is busy checking the feeding habits of the tomcod for possible correlation with the plankton productivity investigation.

only suggestive of the myriad of ocean problems suitable for high school research.

Problems under Investigation at Randolph High School

1. Fishes
   a. Observations on the fecundity of the Tomcod, *Microgadus tomcod* (Walbaum)
   Investigator—Everett Schaner (sophomore)
   Description—Analysis of ovaries taken from 100 Tomcod for fecundity estimate; requiring weighing of a specified number of ova, relating this value to total ovary weight on a seasonal basis including ova, ovary, and fish measurements showing seasonal increase in size until spawning. Average numbers of ova in mature female gave an approximation of Tomcod fecundity.
   Reference: Yuen, H. S. H.
   Maturity and fecundity of bigeye tuna in the Pacific. 1955. U. S. Fish and Wildlife Service, Special Scientific Rept. Fisheries No. 150, 30 pp.
   b. Food habits of the Tomcod *Microgadus tomcod* (Walbaum)
   Investigators—Mary Landry and Nancy Lehtinen (sophomores)
   Description—Stomachs from 50 Tomcod were examined for stomach contents noting the numbers and weight of organisms present, identified to phylum and order, to determine the trophic level utilized by the Tomcod. This information was analyzed with respect to available data concerning Tomcod ecology and abundance.
   Reference: Jensen, A. C., and R. L. Fritz
   Observations on the stomach contents of the silver hake. 1960. Transactions. Amer. Fish. Society, Vol. 89, No. 2, pp. 239-240.

c. Observations on the age and growth of the Tomcod, *Microgadus tomcod* (Walbaum)
Investigator—Peter McGrath (sophomore)
Description—Otoliths, small arrow shaped bones suspended in a watery sinus in the skull, from 50 Tomcod of various sizes were removed and examined to determine their usefulness as indicators of fish age. Annual rings were counted and compared with fish length. In this way an age approximation and growth curve were estimated.
Reference: Lux, F. E.
Age determination of fishes. 1959. U. S. Fish and Wildlife Service. Fishery Leaflet No. 488, 10 pp.

d. Observation of the age and growth of the Longhorn Sculpin, *Myoxocephalus octodecimspinosus* (Mitchill)
Investigator—Gene Cohen (sophomore)
Description—Otoliths were removed from 25 fish of different size groups. Annual rings were counted and compared with fish length to approximate fish age and rate of growth.
Reference: Morrow, J. E., Jr.
The biology of the Longhorn Sculpin, Myoxocephalus octodecimspinosus, *with a discussion of the southern New England "trash" fishery*. 1951. Bulletin of the Bingham Ocean. Coll. Vol. 13, No. 2, 89 pp.

2. Plankton

a. Observations of the nearshore zooplankton fauna collected from Cohasset, Massachusetts
Investigator—Robert Merritt (sophomore)
Description—Zooplankton organisms were collected during the winter months with a fine mesh nylon plankton net using both vertical and horizontal tows of approximately ten minutes' duration. Zooplankters were classified by major groups. An estimation was made of the relative percentage of group composition.
Reference: Deevy, Georgiana B.
Oceanography of Long Island Sound. Part V, Zooplankton. 1956. Bulletin of the Bingham Ocean. Coll. Yale Univ., Vol. 15, pp. 113-155.

b. Observations of the nearshore phytoplankton fauna collected from Cohasset, Massachusetts
Investigator—Fred Hubble (sophomore)
Description—A number of large diatoms were removed from the same plankton collections used by R. Merritt (see above). They were classified by groups. An estimate was made of the percentage composition of each group.
Reference: Conover, Shirley, A. M.
Oceanography of Long Island Sound. Part IV, Phytoplankton. 1956. Bulletin of the Bingham Ocean. Coll. Yale Univ., Vol. 15, pp. 62-112.

Suggested General Problems for Investigation

The following list contains a few suggested problems in each of the three major areas of oceanographic research and includes recent references useful for organizing the investigation.

1. Biological oceanography

a. Follow the distribution pattern in both space and time of a marine organism, fish or invertebrate. This will require the marking of a large number of organisms using tags or other means in order to accurately determine migration patterns and growth rates.
Rounsefell, G. A., and J. L. Kask.
How to mark fish. 1945. Transactions of the American Fisheries Society 73:320-363.
Rounsefell, G. A., and W. H. Everhart.
Fishery science, its methods and applications. Part 7. Tagging of fish. 1953. John Wiley and Sons, New York, pp. 265-296.

b. Determine the relative abundance and species composition of the standing crop of plankton in a selected nearshore environment with respect to space and time.
Bigelow, H. B., and Mary Sears.
Studies of the waters of the continental shelf, Cape Cod to Chesapeake Bay, III. A volumetric study of the Zooplankton. 1939. Museum of Comp. Zoology Memoirs (Harvard University) 54(4): 183-378.
King, J. E., and Joan Demond.
Zooplankton abundance in the central Pacific. 1953. U. S. Fish and Wildlife Service, Fishery Bulletin 54 (82): 111-144.

c. Determine the effects of various stimuli on small marine organisms with respect to orientation and behavior. A marine aquarium is essential to complete a study of this type.
Office of Naval Research.
Proceedings of a Conference on Orientation in Animals, 1953. 1955. Department of Navy, Wash., D. C., 302 pp.
Jackman, L. A. J.
Marine Aquaria. 1957. Cassell and Co., Ltd., London, 138 pp.
Brown, M. E., Editor.
The Physiology of Fishes. 1957. Academic Press, New York, 526 pp.
Waterman, T. H., Editor.
The Physiology of Crustacea. 1960. Academic Press, New York and London, 670 pp.

d. Examine the cranial anatomy of several bony fishes with respect to the pineal apparatus which has recently been subject to orientation experimentation by a number of investigators.
Gregory, W. K.
Fish skull: a study of the evolution of natural mechanisms. 1933. Trans. Amer. Philosophical Soc., N.S., 23(2) 75-481.
Breder, C. M. and P. Rasquin.
A preliminary report on the role of the pineal organ in the control of pigment cells and light reactions in recent teleost

fishes. 1950. Science, 111 (2871): 10-12 fig. 1.

Rivas, R. L.

The pineal apparatus of tunas and related scombrid fishes as a possible light receptor controlling phototactic movements. 1953. Bulletin Marine Science of the Gulf and Caribbean. Vol. 3, No. 3, 168-180.

2. Physical and chemical oceanography
   a. Describe the variations in the movements of nearshore surface water types as defined by salinity (measured in parts per thousand) with respect to seasonal changes.

      Seckel, Gunter.

      An atlas of the oceanographic climate of the Hawaiian Islands region. 1960. Manuscript Library. Honolulu Biological Laboratory. U. S. Bureau of Commercial Fisheries, Honolulu, Hawaii, (to be published).

   b. Describe the general current movement in a selected nearshore environment.

      Iselin, C. O. D.

      Coastal currents and the fisheries. 1955. Papers in Mar. Biol. and Ocean. Suppl. to Vol. 3, Deep Sea Research, Pergamon Press, London, New York. pp. 474-478.

      Riley, G. A.

      Oceanography of Long Island Sound 1954-55. 1959. Bulletin of the Bingham Ocean. Coll., Vol. 17, Article I, pp. 9-30.

   c. Describe the variations in dissolved phosphates and other substances in a selected nearshore environment with respect to seasonal changes.

      Marshall, S. M. and A. P. Orr.

      The relation of the plankton to some chemical and physical factors in the Clyde Sea area. 1927. Marine Biol. Assn. U.K. Jour. Vol. 14, 837-868.

      Redfield, A. C.

      On proportions of organic derivitives in sea water and their relation to the composition of plankton. 1934. pp. 176-192. James Johnstone Memorial Volume, Lancashire Sea Fisheries, Liverpool; 348 pp.

      Lewis, George J., Jr. and Norris W. Rakestraw.

      Carbohydrates in sea water. 1955. Journal of Marine Research. Vol. 14, No. 3, 253-258.

   d. The determination of light penetration in selected nearshore environments.

      Clarke, G. L.

      Diurnal migration of plankton in the Gulf of Maine and its correlation with changes in submarine irradiation. 1933. Biological Bull., Vol. 65; 402-436.

All of these topics are discussed under appropriate headings in the following standard reference:

Sverdrup, H. V., M. W. Johnson, and R. H. Fleming.

The oceans, their physics, chemistry and general biology. 1952. 4th printing, Prentice-Hall Inc., New York. 1087 pp.

3. Geological oceanography
   a. Determination of the bottom sediment-type of selected nearshore areas with respect to rates of deposition.

      Hough, J. L.

      Sediments of Buzzards Bay, Mass. 1940. Jour. Sed. Pet. Vol. 10, 19-32.

   b. Description of the factors responsible for erosion.

      Chute, N. E.

      Shoreline changes caused by the hurricane of Sept. 1944. 1946. Bull. 9, Mass. Dept. Public Works in Coop. with U. S. Geol. Survey.

   c. The determination of the effects of currents on the movement and deposition of suspended particulate matter.

      Stetson, H. C. and J. Fred Smith.

      Suspension currents and mud slides. 1938. Amer. Jour. Sci., Vol. 35, 1-13.

   d. The use of sediment types in determining faunal distribution.

      Sanders, H. L.

      Benthic studies in Buzzards Bay. III. 1960. The structure of the soft-bottom community. Limnology and Oceanography. Vol. 5, No. 2: 138-153.

All of these topics are discussed in the following reference:

Shepard, F. P.

Submarine geology. 1948. Harper and Bros. Publishers, New York, 348 pp.

Data Collection

Perhaps the most important aspect of any research endeavor is the collection of information regarding the various stages of project development referred to as data.

To assure adequate recording of this data it is important to outline the project carefully considering the data to be collected in order to achieve successful results. Mimeographed forms are most useful since in most instances a good deal of replicate type data is needed in oceanographic research. The type of information to be recorded will of course vary greatly with each project. However, in most instances the mimeograph data sheet should contain a few essentials such as project title, date, signature of individual collecting data, and a method of numbering observations.

Reporting Project Results

Investigation results should be presented in a form suitable for publication in appropriate

scientific periodicals. For the most part the projects under consideration at the high school level will be short term investigations which could be prepared as brief observations and scientific notes. Included below is a partial listing of scientific periodicals which will accept for publication short manuscripts containing significant scientific contributions.

1. *Copeia*, published quarterly by the American Society of Ichthyologists and Herpetologists. Managing Editor—
   Dr. David L. Jameson,
   Dept. of Biology,
   San Diego State College,
   San Diego, California.
2. *Journal of the Fisheries Research Board of Canada*, published bi-monthly by the Fisheries Research Board of Canada.
   Editor—
   Dr. W. E. Ricker,
   Fisheries Research Board of Canada,
   P.O. Drawer 100,
   Nanaimo, British Columbia,
   Canada.
3. *Journal of Marine Research*, published by the Sears Foundation for Marine Research, Bingham Oceanographic Laboratory, Yale University.
   Managing Editor—
   Yngve Olsen,
   Bingham Oceanographic Laboratory,
   Yale University,
   New Haven, Connecticut.
4. *Limnology and Oceanography*, published quarterly by the American Society of Limnology and Oceanography.
   Editor—
   Dr. K. M. Rae,
   Dept. of Oceanography and Meteorology,
   A and M College of Texas,
   College Station, Texas.
5. *The Biological Bulletin*, published by the Marine Biological Laboratory, Woods Hole, Massachusetts (will accept only comprehensive studies for publication).
   Managing Editor—
   Dr. Donald P. Costello,
   P.O. Box 429,
   Chapel Hill,
   North Carolina.
   From June 1 to Sept 1 manuscripts should be sent to Managing Editor, Marine Biol. Lab. Woods Hole, Mass.
6. *Transactions of the American Fisheries Society*, published quarterly by the American Fisheries Society.
   Editor—
   Dr. L. L. Smith, Jr.,
   300 Coffey Hall,
   University Farm,
   St. Paul 1, Minnesota.

Scientific publications for the secondary school:

1. *Science World Magazine*, published bi-weekly from September to June.
   Editor—
   Dr. Eric Berger,
   33 West 42nd St.,
   New York 36, New York.
2. *Megalops*, to be published semiannually by the Randolph High School Oceanographic Laboratory. Address Student Managing Editor—
   Mr. Everett Schaner,
   Randolph High School,
   Oceanographic Laboratory,
   Randolph, Massachusetts.

The manuscript should be typed double space on standard 8½" by 11" good grade bond paper. Accompanying figures and tables should appear on separate sheets. Figures should be drawn in India ink on good grade drafting paper. Most all periodicals contain specific instructions pertaining to manuscript preparation and should be consulted. Familiarization with the style used in the periodical selected is essential.

Generally the following headings should be used.

1. Introduction
2. Methods and Materials
3. Results
4. Discussion
5. Conclusions

General References

A. A. Buzzati-Traverso, Editor. *Perspectives in marine biology*. 1958. University of Calif. Press. Berkeley and Los Angeles, 621 pp.

Alee, W. C., A. E. Emerson, O. Park, T. Park, and E. P. Schmidt. *Principles of animal ecology*. 1949. W. B. Saunders Co. Philadelphia, 837 pp.

Barnes, H. *Oceanography and marine geology*. 1959. The Macmillan Co., New York, 218 pp.

Bigelow, H. B. and W. C. Schroeder. *Fishes of the Gulf of Maine*. 1953. Fish. Bull. U. S. Fish and Wildlife Service, Vol. 53. Bull. 74. 577 pp.

Bolin, M., Editor. *The atmosphere and the seas in motion*. 1959. Rockefeller Institute Press, New York. 509 pp.

Brown, Margaret E., Editor. *The physiology of fishes*. 1957. Academic Press Inc., New York, 526 pp.

Cowen, R. C. *Frontiers of the sea, the story of oceanographic exploration*. 1960. Doubleday, New York, 307 pp.

Ekman, Sven. *Zoogeography of the sea*. 1953. Sidgwick and Jackson Ltd. London, 417 pp.

Emory, K. O. *The sea off Southern California, a modern habitat of petroleum*. 1960. John Wiley and Sons. New York and London. 366 pp.

Hardy, A. C. *The open sea, its natural history, Part I. the world of plankton*. 1956. Houghton Mifflin Co., Boston, 335 pp.

Hardy, A. C. *The open sea, its natural history. Part II. Fish and Fisheries*. 1958. Houghton Mifflin Co., Boston, 322 pp.

Hedgpeth, J. W., Editor. *Treatise on marine ecology and paleoecology. Vol. I. Ecology.* 1957. Geological Society of America, Memoir, No. 67, 296 pp.

Jackman, L. A. J. *Marine aquaria.* 1957. Cassell and Company Ltd., London, 138 pp.

Marine Sciences and Research Act. *Report from the committee on interstate and foreign commerce.* 1960. U. S. Senate. Calendar No. 1588, Rept. 1525, 64 pp.

Mayr, Ernst, E. G. Linsley, R. L. Usinger. *Methods and principles of systematic zoology.* 1953. McGraw-Hill Book Co., Inc., New York, 328 pp.

Moore, Hilary B. *Marine ecology.* 1958. Wiley Co., New York, 493 pp.

National Academy of Sciences. N. R. C. *Oceanography 1960-1970. A report by the committee on oceanography in 12 parts.* 1959. National Academy of Sciences, National Research Council, Washington, D. C.

Papers in Marine Biology and Oceanography. *Deep sea research, Suppl. to Vol. 3.* 1955. Pergamon Press, London and New York. 498 pp.

Pratt, Henry Sherring. *A manual of the common invertebrate animals.* 1948. The Blakiston Co., Philadelphia, 854 pp.

Prosser, C. Ladd, Editor. *Comparative animal physiology.* 1952. W. B. Saunders Co., Philadelphia, 888 pp.

Rounsefell, George A. and W. H. Everhart. *Fishery science, its methods and applications.* 1953. John Wiley and Sons, Inc., New York, 444 pp.

Russell, R. C. H. and D. H. Macmillan. *Waves and tides.* Philosophical Library Inc., New York, 348 pp.

Sears, M., Editor. *Preprints, International Oceanographic Congress.* 1959. American Assoc. Advance. of Science, Wash., D. C., 1022 pp.

Scientific American. *Cumulative Index 1948-1957.* 1958. Scientific American, Inc., 176 pp.

Shepard, F. P. *Submarine geology.* 1948. Harper and Bros. Publishers, New York, 348 pp.

Sverdrup, H. V., M. W. Johnson, and R. H. Fleming. *The oceans, their physics, chemistry, and general biology.* 1952. 4th printing. Prentice-Hall Inc., Englewood, New Jersey, 1087 pp.

UNESCO Symposium on Physical Oceanography. *Proceedings 1955 (in English), UNESCO.* 1957. Paris, France, and Japan Society for the Promotion of Science, Tokyo, 292 pp.

Walford, Lionel A. *Living resources of the sea.* 1958. Ronald Press, New York, 321 pp.

Waterman, Talbot H., Editor. *The physiology of crustacea.* 1960. Academic Press, New York, Vol. I, 670 pp.

Technical References

Barnes, H. *Apparatus and methods of oceanography.* 1959. Interscience Publishers, Inc., New York, 341 pp.

Instruction Manual for Oceanographic Observations. 1955. Hydrographic Office publication No. 607, U.S.N. Hydrographic Office, Washington, D.C., 210 pp.

Isaacs, J. and C. Iselin, Editors. *Oceanographic instrumentation.* 1952. Publication 309. Division of Physical Sciences, National Academy of Sciences, National Research Council, Washington, D.C., 233 pp.

Kestevan, G. L. Editor. *Manual of field methods in fisheries biology.* 1960. Food and Agricultural Organization of the United Nations (F.A.O.). Rome, Italy. 152 pp.

Trigger

The trigger that sets off the formation of tissue-building fatty acids is a compound called malonic acid, said Dr. Salih J. Wakil of the Duke University Medical Center. Malonic acid plays an important role in the joining together of small molecules to form the 16-link molecular chain called palmitic acid, a major constituent of fat. Biotin has long been identified as a key substance required in nutrition. In the new work on chicken liver extracts the studies were extended to isolate other substances involved in the complex process of building fats from foodstuffs.

The biotin-containing system found in chicken liver is similar to those found in many other living tissues, both of animal and plant origin, "a fact that attests to the universality of this new system," Dr. Wakil pointed out, continuing:

"The first step beyond the building block in the buildup of fatty acid has been isolated and identified as malonic acid (malonyl coenzyme A). It has been found to be a partner in the reaction which keeps the chain of molecules increasing.

"The theory is the result of a number of clues as to what the participants and synthetic reactions are. It started out with two new observations where both the vitamin biotin and carbon dioxide are required for synthesis. These discoveries led to the isolation from chicken livers of the biotin system, which is involved in the linking of carbon dioxide to acetic acid (acetyl coenzyme A), and the formation of a hitherto undescribed intermediate known as malonyl coenzyme A."

Another pathway for the synthesis of fatty acids has been indicated by other research described by Dr. Wakil. This system is localized in the mitochrondrion—the powerhouse of the cell—and it forms materials of different nature than those observed in the biotin system.

An Experimental Course in Field Biology for Superior High School Students

VON C. ALEXANDER, *Richmond Senior High School, Richmond, Indiana*

My school, like many other schools throughout the nation, has become increasingly concerned for its superior students. Consequently, it is revising its curriculum to include higher level courses designed in content and approach to meet the needs of these students. One of these advanced offerings is an experimental course in field biology taught during the summers of 1957 and 1960.

The course is designed to deepen the interest and broaden the knowledge of these students who have previously demonstrated a liking and aptitude for the subject of biology. It also serves partly as a reward course for work well done and partly as an exploratory course for those considering the field of biology as a possible career.

The course grew out of a belief that many life-time interests in biology begin and grow out of simple, intimate contact with living things. Most of us recall vividly, perhaps after many years, our first experiences in the field or laboratory with special life forms which caught and still hold our interest.

The course is organized as a field and laboratory course entirely. Such lectures and assigned readings as are made have as their purpose preparation for or summarization of specific field experiences. The course is organized in four-hour morning sessions, meeting five days per week for four weeks. The number of scheduled hours exceeds the requirements for the regular one-semester summer course. We grant one semester of credit in science for the work.

The four-hour session, a prime requisite, automatically restricts the students to this one course, and thus frees the group for such special activities as all-day field trips and other shifts of program. Trips are conducted and related to each other by placing emphasis on the structure of the biological community and the ecological relationships of its members. Laboratory study deals with identification and study of organisms collected.

During the first three weeks half-day trips are made to ponds, streams, and woodlands within a thirty-mile radius of the school. On these trips, student drivers, using their own cars, take turns at providing transportation. Actually, this student-provided transportation causes us more concern than anything else, and in order to provide the best possible control, student drivers are under explicit instructions never to leave the caravan, never to overtake the teacher leader, and never to lag. Student drivers have cooperated faithfully, and so far we have experienced only minor difficulties.

One full-day field trip to an area of special interest is scheduled during each of the first three weeks, and since these trips may involve 200 miles or more over heavily traveled highways, we use adult drivers, usually parents.

If at all possible, we enlist the aid of a specialist in the area which is the subject of the full-day visit, and he provides the orientation lecture and directs the trip. We have received help along this line from the Earlham College faculty, park naturalists, and conservation officers. Full-day excursions have included trips to Cedar Swamp, a white cedar bog in Ohio; Whitewater Park, a newly formed lake and recreational area; Turkey Run Park, a stream-cut ravine area; Gray's Bird and Wild Life Sanctuary, a large tract reverting to the natural state; and Dunes Park, a classic example of dune succession.

For the last week of the course the base of operations is shifted to the Earlham College Biological Station at Dewart Lake in northern Indiana. The near-by Friends Church camp provides food and lodging and recreational facilities for students at a cost of $3.25 per day. The station makes available its laboratory facilities, boats, and library. Dr. Murvel Garner, the director, assists with the week's activities.

Included in the week unit of the lake are lectures on its origin, its fate, and its organiza-

tion as an eco-system. Lake trips are made to study the aquatic plant succession, to determine the physical structure of the lake, and to collect study materials. Laboratory sessions are devoted to identification of organisms and a study of relationships.

Sessions at the lake are conducted both morning and afternoon, with early release for swimming and boating. One or more field trips are organized from the station, an example being the Dune Park trip, which was made by the combined college and high school groups.

Obviously, this week is the highlight of the work, and it is used to terminate the course. However, students are given until the end of the regular summer session, approximately four weeks, to complete reports and projects. This special work stresses personal observation and independent study, and the requirements have been set up with these goals in mind.

Each student is charged during the first two weeks with a thorough study of the only text, *Basic Ecology*, Buchsbaum and Buchsbaum, Boxwood Press, 1957. Also required are detailed papers based on personal observation on the "Nature of a Biological Community" and on "Succession." In these papers the student is asked to develop the concepts by reference to specific areas visited and by detailing personal observations. This requirement is designed to provide a common goal for the group; i.e., a general understanding of the ecology of the area being visited and the identification of its key members.

Each student is asked to select a special phylum or class, either plant or animal, as a special study project. Data on examples, identification, etc., are kept on 3 x 5 cards. The card file or the preserved specimens constitute the project record.

Students taking the course are selected on the basis of ability and interest, and only those with A or B marks in general biology are considered. Those majoring in science also receive preference. Students may enroll only if granted permission to do so by the teacher after a personal interview. Students also must have written permission from parents to ride with student drivers.

The materials and equipment needed for this type of course are not extensive. In addition to the basic text, there is a need for keys, such as the Jacques and Peterson series, covering the various phyla. A microscope should be available to each student for his exclusive use. Students usually own or can borrow enough binoculars to supply the group on bird trips. However, a seine, a plankton tow net, and two plankton hand nets are needed. Plant presses and collecting kits, if not available, are easily improvised. We have found an iced camp cooler useful in transporting and maintaining plankton and similar sensitive samples.

We have attempted to determine student reaction to the course by means of a questionnaire. The response to the question, "Did you enjoy this course and would you recommend it to others as a worthwhile educational experience?" has been unanimously favorable. The four-session, all-day trip, and the week at the lake have received an equally favorable response. Many felt that the course could be extended one or two weeks with profit. On a question to determine preference between concentration on a special phylum as a project and a study of a broad sampling of life forms, the response was about equally favorable to each procedure. This could indicate that both approaches might be offered with the student choosing the one best adapted to his interests.

It is the opinion of the participating students and me that the course successfully accomplishes its purpose—that of broadening and enriching the students' biological background through personal experience with living things.

Fellowships

The John Hay Fellows Program announces the availability of summer and year fellowships in the humanities and sciences for teachers in public senior high schools. For information write Greenwood Fund, 9 Rockefeller Plaza, New York 20, New York.

Career Publication

"A Career in Physiology: Your Challenge and Opportunity" is available from The American Physiological Society, 9650 Wisconsin Avenue, Washington 14, D. C.

The Importance of Biological Research

WILLIAM A. HILTON
Pomona College, Claremont, California

Many like to think all human knowledge as one great field with its subdivisions developed more for convenience of study than because they are essentially different. In any case, none of us would deny the fact that the sciences are closely correlated and that they frequently overlap. It used to be that subject matter and methods separated them, but now neither is more than partially true. It is, however, convenient to think of physics as a study of energy, chemistry a study of matter, biology a study of life, and so on, but this is not a perfect separation, and when it comes to methods there are other difficulties. A biologist and a chemist for instance, might work in the same laboratory, use the same materials and methods, and reach the same results. Yet one might be considered a biologist and the other a chemist; one would be interested in the results as related to chemical problems and the other in its relation to life; in other words, the main difference would be in the point of view.

In much of modern biology it is often important and frequently necessary to use the findings and methods of mathematics, physics, or chemistry in solving its problems, but there is some danger of loosing sight of the main theme: the comprehension of life in all its manifestations. Useful as are the methods and materials of other sciences, there is much left over that cannot be explained by any one or all of them combined. Even when chemistry or some other subject seems to solve the whole problem in biology, there is much left untouched when life itself is not considered.

Important as are the discoveries and development in this atomic age, we must not loose sight of the fundamental value of biological research for humanity. We are now giving more money and attention to atomic and allied research than to the solution of biological problems which are more directly related to life and human organisms. This may be understood and partly forgiven because of the pressure of war fears and the necessary protective measures. Unfortunate also, has been the great urge to enter into a type of research which is so well advertised and supported.

One of the reasons that biological sciences have been slighted is due to the mistaken idea that these areas are less difficult and less worthy of the highest efforts of the best minds.

It is true that there are many fields of biology which require less preparation to enter than is the case with some of the other sciences, but in the long run all great questions are equally difficult to answer. It does not matter much what area one enters, the ultimate problems are there. As David Starr Jordan once said many years ago, "All the easy things have been done."

The old conception of pure science as being entirely apart from any application to human use seems rather absurd to us now for there have been so many discoveries which seemed totally outside of any direct value to man that have proved to be of the utmost importance in applied science. We now recognize more than ever before that practically every research in pure science will sooner or later be valuable for man.

However, it is well to keep to the ideals of pure science. When doing research in this field it may be fatal to an investigation if applications be constantly sought, for this might lead to neglect of the apparently unimportant but really valuable principles or explanations. There should always be investigators in every science who are interested only in principles and are always ready to follow where facts may lead without being sidetracked by some possible practical application. We need to encourage many in the pure sciences; applied research will then develop naturally.

The central problem of biology is a better comprehension of protoplasm and the nature of life. There are numerous aspects and phases; there is possible an almost unending source of information. Almost every branch of biology has its contribution towards a better understanding of this most important phenomenon of the world in its value for us.

The nature of the living substance or protoplasm has been approached in many ways. In

recent years chemistry and physics have given us clearer conceptions than we ever had, but still much eludes us. The study of hormones, vitamins, and other products of the cells instead of solving all problems have brought forth still others. The study of heredity, both cellular and external, has profoundly affected man and given him a better knowledge of all living things, often greatly to his social and economic advantage. The better knowledge of physiology and disease has greatly lengthened man's life and eased his pain. Disease after disease has been brought under control and more are being investigated. Perhaps cancer, heart diseases, and other modern killers might more quickly be reduced or eliminated if a fraction of the money spent on armaments, military preparations, and nuclear research could be applied to man's immediate benefit.

We do have a war on right now, not only against disease but against insects. It has been suggested by entomologists that it is still an open question whether man will succeed against the insects with their wonderful powers of reproduction and their great adaptability. It has also been said that man could not continue to live on this earth more than three years if the insects did not war upon themselves.

There are so many pressing problems in the field of biology that it would take pages to merely enumerate them. Some that have been prominent have been concerned with heredity and development, the nervous system and its sense organs, disease and immunity. There is also the growing interest in resources for the future. Can we continue to produce plants and animals by the wasteful methods we have been using? How long can this continue? How long before our natural resources will be exhausted especially with the undreamed of increases in world population?

Such questions and many more are being considered with now and then some considerable hope of satisfactory answers; for example, the artificial manufacture of chlorophyll. If this can be accomplished, then green plants, the basis of life on earth, can have a substitute of far-reaching importance. Some also hope that nuclear energy may in time be used directly by the human body.

Some of the recent aids to the understanding of living things, and their activities have come through the study of viruses. Long before their identities were known, these were said to cause some of our most terrible diseases —hydrophobia, smallpox, yellow fever, polio, and many others. By the use of modern methods, including the electron microscope, these were identified, but whether they were chemical or living bodies is still in some doubt. They sometimes appear in crystalline form and do not reproduce outside living cells, which may suggest a lower organization than that of protoplasm, but they appear highly complex although very small as compared with bacteria. In some cases, at least, they possess an outer layer of protein material and an inner part of nucleic acid and suggest something like a living substance. In many ways the most interesting are the bacteriophages which attack bacteria. They were first known in 1915 but better understood when the electron microscope came to be used in 1938. They appear to be little balls with a short stem or tube on each one; the outer parts are protein, the ball contains nucleic acid which is injected into the bacterium by means of the hollow stem or tube. Nucleic acids, similar to those of the chromosomes, change the activity of the cell attacked, causing the heredity substance, chromatin, which is similar to that injected, to alter its activities and aid in the production of other compounds or viruses like those which had penetrated the living organism. In this peculiar way reproduction of the virus is accomplished with the destruction of the bacterium, something like hereditary substance having entered the cell and changed its whole metabolism.

By careful study of this strange activity, there may be valuable information obtained about the nature of chromatin and its part in the transmission of hereditary characteristics.

Enthusiastic students of the viruses have said that this line of inquiry is more important to man than all the atomic energy projects which engage the attention of so many scientists today. These biologists have said that virus study is leading us towards an understanding of functions and activities of living substance, of life itself. Such researches would also bring about the banishment of the terrible virus diseases and furnish more accurate knowledge for the control of human and animal inheritance.

Acid plus Base → Salt plus Water

FRANK E. WOLF
State College, Fitchburg, Massachusetts

Introduction

The following exercise is useful in biology as a simple experiment illustrating the principle of neutralization. This would follow an introduction to acids and bases. The exercise is useful, as well, in chemistry where the use of microtechniques is assuming increasingly wide acceptance.

Although this experiment is usually performed in chemistry classes, it is done in test tubes and proof of the formation of salt is inferred from negative test results for acid and base. The described modification allows students to actually see salt crystals with their characteristic shape under the microscope.

Materials and Preparation

Student microscope, glass slides, cover glasses, two eye droppers, hydrochloric acid (concentrated), sodium hyroxide (10%).

Procedure

Each student will examine a drop each of the acid and sodium hydroxide under the microscope. Both materials should be covered by a cover glass and examined under the low and high dry objectives. It will be observed that the liquids are clear and free from observable particles. Each student will then place a drop of the sodium hydroxide directly over the acid. Cover with a cover glass and wait a few minutes until a cloudy precipitate begins to develop, which can be seen with the naked eye. Place slide under the microscope and observe under low and high dry objectives. Characteristically shaped sodium chloride crystals will be seen in the previously clear liquids.

Discussion

The sodium from the hydroxide and the chlorine from the acid have combined chemically to form sodium chloride or table salt. Sodium is a violently active metal and chlorine is a poisonous gas; however, together they form an essential regulatory compound without which we could not long survive.

This experiment illustrates a form of chemical reaction usually taught as an introduction to cellular metabolism. Its applications to the digestive and circulatory systems, the muscles, etc., could be made. For example, the saliva is usually acid, but the bolus is alkaline before reaching the acid environment of the stomach. The pyloric sphincter opens partially due to a shift in pH toward the alkaline side which is the environment of the small intestine, while the urine is usually acid.

New NABT Officers

Congratulations to the newly elected NABT officers:

PRESIDENT: Paul Webster, Bryan High School, Bryan, Ohio.

PRESIDENT-ELECT: Muriel Beuschlein, Chicago Teachers College, Chicago 21, Illinois.

FIRST VICE-PRESIDENT: Clarence Goodnight, Purdue University, Lafayette, Indiana.

SECOND VICE-PRESIDENT: Brother G. Nicholas, Notre Dame University, Notre Dame, Indiana.

THIRD VICE-PRESIDENT: Robert L. Smith, DeKalb High School, DeKalb, Illinois.

SECRETARY-TREASURER: Herman C. Kranzer, Temple University, Philadelphia 22, Pennsylvania.

RECORDING SECRETARY: Audrey E. Pressler, Frederick High School, Frederick, Maryland.

REGIONAL DIRECTORS:

Region I: Irving Keene, Weston High School, Weston, Massachusetts.

Region II: Glenn C. Ball, Carthage High School, Carthage, New York.

Region III: John Gundlach, Neenah High School, Neenah, Wisconsin.

Region IV: Rex Conyers, University City Public Schools, St. Louis County, Missouri.

Region V: William Foil, Hanes High School, Winston-Salem, North Carolina.

Regions VI, VII: Clyde T. Reed, University of Tampa, Tampa, Florida.

Region VIII: Stanley B. Mulaik, University of Utah, Salt Lake City, Utah.

Region IX: Irene Hollenbeck, Southern Oregon College, Ashland, Oregon.

Building a Terrarium

CHARLES CROMBIE
LaPine High School, LaPine, Oregon

Biology classrooms without living materials would be rather uninteresting places. Battery jars and aquariums *can* be used for terrariums. Battery jars often have curved sides, are of colored glass, or are not a practical size. Aquariums are too expensive in the larger sizes and too scarce in a classroom, to serve for frogs, toads, salamanders, and lizards.

I have found terrariums can be made by students for little cost and yet be very satisfactory. Materials required are:

1. Board—for the base, approximately 2 inches larger each way than the finished terrarium.
2. Window glass.
3. Adhesive tape—for the frame, 1-2 inches wide.
4. Quarter-round molding—equal to the perimeter of the base.
5. Paint.
6. Nails.

The base is made first by nailing the quarter-round around the edge of the board as in Figure 1. Molding corners should be mitered for a neat job.

Lay the glass out as in Figure 2, leaving about 1/16 inch gap between each piece of glass. Cut adhesive tape strips about 2 inches longer than the glass. Tape each joint, being careful to see that the gap between the glass is in the middle of the tape strips. Press the tape well to the glass and fold over top and bottom edges. Stand the glass on edge, fold to the final shape, and seal the last corner with tape.

Seal the inside of each corner with tape after the glass has been set inside the frame. Tape the top edge of the glass as a protection from sharp edges.

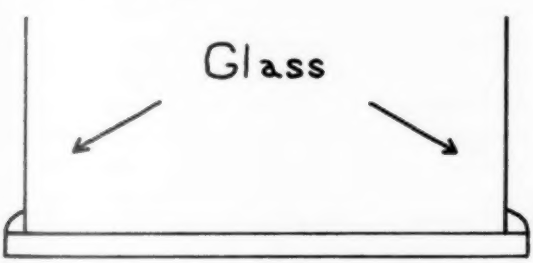


Figure 1

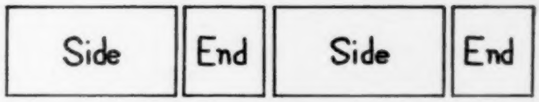


Figure 2

Paint all the adhesive tape and the base. A second coat on the inside will protect the base. The adhesive tape changes in appearance when it is painted and gives a neat finished product.

If the glass available will not make a deep enough terrarium modify the construction. Use 1″ x 2″ or 1″ x 3″ boards in place of the molding. Run the boards through a table saw and cut a groove about ½ inch deep in one edge of each board. Nail the boards on the base in place of the molding. Assemble the glass as usual but insert in the grooved boards. No glass depth is lost serving as the container.

Terrariums built using either of the methods described have several advantages:

1. Economy—scrap lumber and glass is used and no expensive frame is required.
2. Flexibility—the terrariums may be of any size.
3. Simplicity—students can complete a terrarium in 1 or 2 laboratory or shop periods. I saw a 5th and 6th grade class complete a terrarium, except for painting, in 45 minutes.
4. Availability—the materials needed can be easily found in most any community or school.

I have used a number of terrariums made as described above. I have always found them satisfactory. Why not have a terrarium for your class this year?

History of Wild Life Research

A new publication is available on this topic from the Section of Wild Life Research, Illinois Natural History Survey, Urbana, Illinois, and it is an article written by Thomas G. Scott. Single copies are free upon request to the Survey.

Teaching Microbiology in High School Biology*

DAVID L. FAGLE

Marshalltown High School and Marshalltown Junior College, Marshalltown, Iowa

Often it has been said that the largest gap in the American educational system is that which exists between the high school and the college. Because of the ardent endeavors of the National Science Foundation and committees such as the Committee on Education of the Society of American Bacteriologists, spear-headed by Prof. L. S. McClung, this chasm in training is beginning to close. This closure is gratifying to see in a field such as microbiology, since microbiology has often been neglected in the secondary science curriculum.

One must look only to the requirements set forth in the Advanced Placement Courses to observe how important this topic microbiology really is to the college preparatory curricula found in this country's finest high schools. Prof. Willis Johnson of Wabash College has done a magnificant job in helping to develop the biology portion of the Advancement Placement Studies. With this knowledge one may ask: why is microbiology seldom taught in the average high school biology class? I should like to pose some answers to this question!

The word microbiology is unfamiliar to many high school biology teachers, and if the word microbiology is familiar, it is all too often frightening. Many of the biology teachers allow subjects like microbiology to go fleeting by while they drill on the merits of athletic accomplishments of the school. But why not? Their training has been in athletics. My charge would be to the colleges who prepare the teachers of American schools that they require every biology teacher, who will be so accredited, to take at least one college course in microbiology.

There are some other factors regarding the teaching of microbiology in the average American high school that must also be considered. Many teachers will say that the expense of teaching a unit in microbiology is exorbitant. These same teachers may contend that the equipment necessary for teaching a unit in microbiology is money ill spent since the equipment it not used in any other unit. Some teachers will point out that it is dangerous to work with microorganisms because we all know that most microorganisms are deadly devastating demons of destruction. Other teachers will attempt to side-step the problem by indicating that they cannot teach even the basic fundamentals of microbiology without the students having had chemistry. All of these statements are rationalizations because the general introductory principles of microbiology can be taught in even the most remote, poorly equipped, schools in this country.

Any high school biology teacher can teach a major unit on microbiology if he is willing to spend time with interested students, is able to motivate the average students, and is capable of making improvised equipment. An active, interested teacher will create an active, interested class.

Introductory principles of microbiology can be taught for a few cents and much implementation upon the teacher's part. Any biologist who has ever taken a general college course in microbiology realizes that most bacterial cultures used in the high school laboratory are completely harmless. Only cultures obtained from a known culture collection should be used at the high school level.

What concepts and ideas can be taught in the high school laboratory about microorganisms is a question that even the best high school biology teacher often asks. Since many biological principles can be adequately illustrated with organisms from the microcosm, microbiology seems to be very adaptable to the high school biology laboratory course.

Now to the actual teaching of microbiology in Marshalltown High School. As in most high school biology classrooms, much of the simple necessary items for teaching about microorganisms was observably deficient when I first entered the school. To this school I brought the items I had constructed when working out my master's thesis. These items

*Presented at the Annual Meeting of the Society of American Bacteriologists, Philadelphia, May, 1960.

Figure 1. Improvised Microbiology Items: A. Tin can incubator, B. Aluminum foil petri dishes, C. Cotton and toothpick swabs, D. Counting box, E. Hand-drawn pipettes, F. Pencil inoculating needle.

are displayed in Figure 1. Figure 2 shows items that were obtained from the school and community.

The first thing my students do in making a study of microbiology is to gain an understanding of which living organisms are considered microorganisms. The students are asked to illustrate their accumulated knowledge by constructing a worthwhile bulletin board. This activity will give students an awareness of the organisms they are seeking.

Next, all of the items necessary for culturing microorganisms are assembled by the students. These materials are: culture media of some type, screw top prescription bottles, flasks, test tubes, cotton, toothpicks, filter paper, a pan or large beaker, a large pressure cooker, a glass rod, some means of heat, a few glass petri dishes, and a large quantity of aluminum foil.

After the preliminary study of the characteristics of microorganisms have been made and the principles of microbiology have been introduced, the class is divided into laboratory work groups. Group One is to make up a few liters of culture media; the dry nutrient agar is used in my classes. This technique demands teaching standard measurement methods regarding milliliter and gram relationships. While the media is being made, Group Two is busy cleaning bottles and flasks to contain the media. When nutrient agar has not been available, I have substituted bouillon cubes and gelatin as well as sliced vegetables. While the media is being prepared, Group Three, which is the largest group, is busy making aluminum foil petri dishes.

These aluminum foil petri dishes are the most expendable type of culture containers that can be used in the classroom. Their cost is small while breakage and storage problems are eliminated. When the students have finished making the dishes, the dishes are placed carefully in a large cardboard box to await oven sterilization.

Since pipettes are used extensively in microbial work, a fourth group of students is given glass tubing which they pull in a flame and calibrate using a one milliliter measurement. A pipette calibrator can be constructed

so a standard unvarying measurement can be made.

A fifth group of students can make swabs from toothpicks and cotton and also cutout a good supply of filter paper discs using a one-quarter inch cork bore. All of these laboratory procedures can take place in one fifty-five minute laboratory period.

A few of the interested and adept students are selected to stay after school and help sterilize the prepared items. The culture media and some measured quantities of distilled water are placed in improvised wire baskets in the pressure cooker. It usually takes about one hour to build up adequate pressure to facilitate sterilization. This is usually done in the home economics room since the facilities are very handy. While the culture media is being autoclaved, the petri dishes, aluminum foil wrapped pipettes, paper discs, and toothpick swabs are put in the home economics oven and baked at 325°F for two hours. At times members of my very active science club perform laboratory tasks such as the sterilization of media and equipment.

Since the person and the laboratory environment are rich in microflora, many different areas are investigated for the presence of such flora. One good start-point for high school students is the "Bacteriology of a Kiss." Other areas of investigation are the hands, room objects, soil, drinking fountains, and lab animals. Interesting comparative experiments can be made. The students are amazed at the array of microorganisms they find displayed on the culture plates the next day.

After surveying the universal occurrence of microorganisms, we are ready to study some known bacterial, mold, and yeast strains. During the past few years Dr. Lockhart of Iowa State University has been a real boon to bacteriology in my school by providing requested non-pathogenic strains to us. Students seem to derive tremendous self-satisfaction from cultivating known strains of microorganisms and following this up by making pure cultures from mixed broth cultures.

Transfers and inoculations are made using a home-made inoculating needle made from

Figure 2. School Microbiology Items: A. Dry nutrient agar, B. Triple beam balance, C. Media preparation items, D. Pressure cooker, E. Sterilized media, F. Wire basket, G. Pipettes and inoculating needles. H. Plastic petri dishes, I. Incubator, J. Slides, K. Stains.

a nichrome wire and a pencil. Another splendid technique that students find easy to work with is the "hockey stick" spreader method; it is especially useful in inoculating entire plate surfaces.

Students can evaluate their pure culture technique by making a gram stain. This is the only part of determinative bacteriology used in the course.

The slow student I find often stimulated by working with the chromogenic bacteria. These students can get understandings and concepts when painting with living organisms and showing temperature relationships to pigmentation.

The highlight of the bacterial study comes when students work with anti-bacterial agents such as antibiotics, sulfanilamides, antiseptics, disinfectants, and other chemotherapeutic agents. In this phase of microbiology the average students can work with prepared antibiotic discs and the "hockey stick" spreader method, while the advanced students utilize the gradient plate techniques in making their study.

Molds are often studied. Interesting investigation can be made showing their antibacterial properties. Identification of contaminating types is often undertaken by some of the interested students.

Yeasts have been used very little in my high school biology class. They have been used only for microscopic investigation regarding their asexual method of reproduction.

Protozoa are also studied by my classes but from a morphological and not physiological aspect. They are adequately covered in a phylogeny unit.

Students who are really interested are encouraged to take microbiology as a project topic in their science club work. Here stimulated students independently study bacteriophage, bacterial resistance, and mycology related to antibiosis.

Although only the surface of microbiology has been explored by the eager students, many have been introduced to a new world, the microorganism. For many students this is their first true experience with the living effervescing subjects found in the microcosm. It is at this stage that you, the college professors, receive these students, energized and active, anticipating, and fascinated by the new realm of dazzling discoveries.

Purchase Guide Supplement

An up-dating of the *Purchase Guide* of 1959 in the form of a 64-page *Supplement* will be published in January, 1961 by the Council of Chief State School Officers, 1201 Sixteenth Street, N.W., Washington 6, D. C. The new section will be organized on the same plan as the 344-page *Guide*, and the two books are intended to be used together in selecting equipment for instruction in science, mathematics, and modern foreign languages. Approximately 43,000 copies of the *Supplement* will be distributed without cost to state and local school systems throughout the country. An equal number of copies of the *Guide* are already in use in connection with local and state projects under the National Defense Education Act.

Like the *Guide*, the *Supplement* stresses new and advanced materials, equipment, and course content in the basic sciences. But it goes further than the *Guide* in some fields. There is a special emphasis on audio-visual aids of all kinds. New guidelines on modern foreign languages and educational television reflect experience and changing ideas in these rapidly growing fields during the past 18 months. The teaching machine is introduced for the first time. The most recent developments in the field of biology are included.

Skin Cancer

Irreparable damage to one of the body's most important chemical factories has been tied to the spread of skin cancer in test animals. Breakdown of a sensitive cellular agent, called the fibroblast, prevents the formation of collagen, a protein normally found in abundance in the skin, suggested Dr. I. Gordon Fels of the Veterans' Administration Hospital, Hines, Illinois. A decrease of collagen in animal skin tumors was indicated chemically by the gradual disappearance of an essential chemical building block for collagen, called hydroxyproline.

Book Reviews

A Synopsis of Biology, W. B. Crow, xv + 1056 pp., $17.00, John Wright and Sons, Bristol, (Williams and Wilkins, Baltimore, Maryland, exclusive U. S. agents), 1960.

Too many college biology majors graduate without having the experience of using a textbook published outside the United States. For the average student, the serious study of a text in a language other than English is too time consuming, but much can be gained by having him do some reading in a text published in the British Isles. The approach to the study of biology is different enough to make such assignments valuable.

Crow, in his preface says, "In this work an attempt is made to summarize, as far as possible within the limits of a single volume, the whole of biology, and this means brevity." The treatment of each subject *is* brief in this book, but it is amazing how many subjects are covered. The index comprises 80 pages of double columns. Technical terms are given in bold faced type in the text and there are frequent cross-references. There are 327 illustrations. Most of these are clearly labeled line drawings. The pictures, themselves, seem less sharp and attractive than those found in textbooks published in this country. Documentation is scanty but probably would be impossible in a work of this kind.

Although some students may find this work helpful in studying for comprehensive examinations in biology, its most frequent use will be as an encyclopedic reference. In this role it will be a valuable addition to the biologist's reference shelf.

John M. Hamilton
Park College
Parkville, Missouri

The Biotic World and Man, Lorus J. Milne, Margery J. Milne, 530 pp., $7.95, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1958.

A second edition of an outstanding work for college level classes, but it should be considered for advanced biology in high schools, or at least as a reference. The sequence of material is not orthodox, nor is the treatment of orthodox material. There is quite a bit of orientation material for the biology course, followed by some taxonomy. One interesting chapter is on biological organisms as they affect man. The text then moves to the cell and then some chemical and physical principles concerned with it. The section on bacteriology leaves much to be desired, but the emphasis on genetics and evolution is excellent. Ecology is treated in an unusual manner and the concepts of conservation with an eye to the future. Illustrations are excellent. Consider this for the advanced biology course.

P. K.

Laboratory Manual in General Biology, Lorus J. Milne, Margery Milne, 162 pp., $3.75, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1958.

Written to accompany the biology text by the same authors. It is bound as perforated sheets with outline drawings included. The reviewer was puzzled as to how the basic text could lend itself to laboratory work, but this book soon answered the question. It begins with taxonomy and then moves to the fetal pig as a mammalian type exercise. There is some emphasis on evolution and genetics but microbiology suffers in the process. There is an excellent section on plants, but all in all, traditional laboratory work is the outstanding feature.

P. K.

Mushrooms of the Great Smokies, L. R. Hesler, 289 pp., $5.50, The University of Tennessee Press, Knoxville, Tennessee, 1960.

This field guide, based chiefly on Dr. Hesler's extensive collections in the Great Smoky Mountains National Park, will be equally useful throughout the southeast and of interest and value to amateur mycologists everywhere. Following a brief but adequate introduction which includes a stern warning against unrestrained eating of collections, the author presents keys for identification, description, and handsome photographs of 183 species representative of the rich and varied fungal flora of the Smoky Mountains. He comments on the habitat and edibility, or lack thereof, of each. The text is written in a clear and largely nontechnical style which permits a refreshingly brief glossary.

A disadvantage of field guides such as this is that they cannot treat all the fungi of an area. About two thousand species are known from the Great Smoky Mountain National Park alone, chiefly through the efforts of Hesler. From this overwhelming array of organisms, the author must choose those which are most frequent and most representative. Hesler has chosen well. He has included an impressive number of species

which are not mushrooms in the usual sense, that is to say, gill fungi, but which are conspicuous and frequently are collected by the curious amateur. *Xylaria, Cordyceps,* and stinkhorns, for instance, frequently strike the fancy of collectors but are usually ignored in popular manuals.

Mushrooms of the Great Smokies will be a valuable addition to any science library. It is a must for mushroom hunters and should be recommended to every interested student with fungus.

Robert Johns, *Indiana University*

BIOLOGICAL AND CHEMICAL CONTROL OF PLANT AND ANIMAL PESTS, L. P. Reitz, Ed., xii + 273 pp., $5.75 ($5.00 to A.A.A.S. Members), American Association for the Advancement of Science, Washington, D. C., 1960.

Too often in our biology teaching we devote our entire courses to principles and types and fail to point out the practical aspects of our subject. Students come to us and say, "I like biology, but I don't want to be a teacher and there is nothing else for a biologist to do." A symposium presented by Section O at the Indianapolis meeting of the A.A.A.S. in December, 1957, provided some answers to these students, and the papers given there are now published. The papers in this volume provide material which can be incorporated into courses to stimulate interest in applied biology.

The papers are in three groups. The first, *The Public's Stake in Pest Control*, discusses some of the general problems of control, methods used, education for use, and regulation. The second section, *Recent Advances in Chemical Control*, includes discussions of fungicides, bactericides, herbicides, insecticides, and the chemical control of internal parasites of domestic animals. In this section there is a discussion of the methods, but one is left with the feeling that much more should be said about the ecological consequences of the widespread use of these substances.

The final section, *Biological Control of Pests*, is composed of ten papers on a wide spectrum of biological control methods. As in the first two sections, there are variations in the quality of the individual papers, but they contain much of interest to the teacher and student. Knipling's paper, *Control of Screwworm Fly by Atomic Radiation*, is particularly well written and can be used as a paper for a student report, even at a fairly elementary level.

John M. Hamilton
Park College
Parkville, Missouri

A BOOK ABOUT BEES, Edwin Way Teale, 208 pp., $1.95, Indiana University Press, Bloomington, Indiana, 1960.

A paperback reprint of the original, "The Golden Throng." Profusely illustrated, as you would guess by the author's name, it is the type of book that would be good for the general reading shelf of the library as well as the biology laboratory library. Chock full of information about bees, the author describes in his beautiful prose the research findings about these interesting insects, but he also includes a great deal of lore concerning them. In fact, this may be a fault in that lore and research findings are not too carefully delineated. However, the book is a delight to read as well as being quite informative. Highly recommended.

P. K.

ANIMAL PHYSIOLOGY, Knut Schmidt-Nielsen, 118 pp., $1.50, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1960.

This book presents a vast amount of information in 118 pages. It is most certainly not merely an outlined presentation of the subject of physiology but a well written coverage of the field. The chapter on the problems of water balance is especially outstanding. There are a few minor points for criticism. Some exception may be taken to the statement that the platelets are the source of thromboplastin. Also, Figure 35, which anatomically compares the parts of the autonomic nervous system, does not clearly back up the text statement that parasympathetic secondary ganglia are "frequently in the immediate vicinity or even inside the target organ."

The major criticism in the mind of the reviewer is the handling of the endocrine system. It is realized that the interactions and integrative mechanisms of this system make a short discussion quite difficult and that it is better to leave much unsaid rather than attempt to explain the subject in a scanty manner. However, the whole section gives the appearance of having been hurriedly written, and certainly it doesn't compare with the quality of the earlier chapters. Just to mention a few shortcomings in this section: the table

on hormones does not mention gonadotrophic action on the testes; estrogens are not mentioned in the text; therefore, their augmenting action with progestrone to build up the uterine lining is omitted although it is stated that this lining is "sloughed off if pregnancy does not occur." Thirdly, the inference is strong that the corpus luteum secretes progestrone only during pregnancy, and finally, no mention is made of the hypothalamic influences on the adenohypophysis. Perhaps less space should have been given to the doubtful hormones, histamine and serotonin, and these other subjects mentioned.

These criticisms, however, should not detract from the many fine points of the book. We may speak most favorably of the author's comparative approach to physiological problems. Closely related to this is the use of interesting exceptions to the general rule of things. This can be seen in the discussion of symbiotic digestion using the cases of the termite and honey-guide. On occasions, practical applications of physiological events are presented, such as why papain can be used as a meat tenderizer, why dicoumarol kills rodents, and the use of ammonium salts as a source of nitrogen for cattle. Also, mention is made of the fact that there are many unsolved problems in this field, and examples range from the problem of gases in the floats of invertebrates to mammalian muscle contraction. In addition, several simple experimental techniques are presented.

All in all, there is an interesting and lively presentation of the subject. I believe its chief value would be as a reference or outside reading book for superior high school or undergraduate biology students. It would certainly serve to stimulate and further the student's interest in physiology in addition to supplying specific information. A graduate student could profitably use this book for review and an instructor also will find this book a valuable source of material that can help bring a fresh approach to his lectures.

Frank Zeller
Department of Zoology
Indiana University

AN INTRODUCTION TO ANIMAL BIOLOGY, Fifth edition, Braungart and Buddeke, 416 pp., $6.25, The C. V. Mosby Company, St. Louis, Missouri, 1960.

This is another edition of a college zoology text. The arrangement of the textual material is the orthodox phylogenetic approach with a chapter on embryology and histology between chapters on Protozoa and Porifera. The illustrations are good. But although evolution and genetics are taken up, and the human body is described as a mammalian example, no information is offered on the reproductive system.

P. K.

ANIMAL GROWTH AND DEVELOPMENT, Maurice Sussman, 114 pp., Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1960.

Another one of the paperbacks in the Foundations of Modern Biology series. If these are to be used in a supplemental way, the editors have picked quite an appropriate topic for use in most biology courses—and certainly in the secondary school variety. While some traditional vertebrate embryology is taken up, there is an interesting emphasis on biochemical embryology. A great many instances of experimental work are employed in the descriptive text, and these should prove to be valuable for secondary school students looking for project ideas. There is also an excellent treatment of a variety of cellular phenomena especially in the reproductive phases. The background of DNA is utilized throughout. A final chapter on growth dynamics shows in a beautiful but simple way how mathematics is involved in the biology of growth. Should be not only on the shelf of every biology room but actively in use—at least by the teacher.

P. K.

POSTURAL FITNESS: SIGNIFICANCE AND VARIANCES, Charles LeRoy Lowman and Carl Haven Young, 341 pp., $7.50, Lea & Febiger, Philadelphia, Pennsylvania, 1960.

Written for the physical educator and those interested in school health problems. Although much of the book is of a "preachy" nature, it does come to grips with the issues. The authors define "normal posture" in the best treatment the reviewer has seen. Elaborate descriptions of deviations from this norm are described. The close relationship of postural defects and vocational demands as well as with physical defects, congenital or acquired, are gone over in great detail. It is a little difficult to discover what relationship the authors see between posture and physical condition, which is cause and effect, but it is certain that they understand that there are important relationships. The appendix contains detailed postural remedial exercises.

P. K.

A GUIDE TO THE STUDY OF DEVELOPMENT, William W. Newby, 217 pp., $4.00, W. B. Saunders Company, Philadelphia, Pa., 1960.

This is a laboratory guide for embryology, but as in Balinsky's book, reviewed elsewhere in this journal, the treatment attempts to weld the traditional approach of serial sections of chick and pig with more advanced techniques of experimental embryology. The drawings are very well done. Theoretical problems in embryology are taken up, and the last chapter is on embryology and evolution. Very well done.

P.K.

STRUCTURE AND FUNCTION OF THE BODY, Catherine Parker Anthony, 144 pp., $3.00, The C. V. Mosby Company, St. Louis, 1960.

A brief anatomy and physiology text for students in practical nursing programs. Written simply and amply illustrated the book is a review of human anatomy by a well known author in this field. There is an extensive glossary. Teachers dealing with this type of student should consider this work seriously.

P.K.

CLASSIC PAPERS IN GENETICS, Editor: James A. Peters, 282 pp., Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1959.

Another "must" for the biology library. A paperback, the editor has collected the significant papers in the history of genetics with illustrations included. Naturally enough, Mendel's paper begins the volume. But it is the editor's comments which need notice here. He has introduced each paper with a few informative paragraphs, assessing its value in the history of genetics, and giving a few personal slants on the author and his paper. Even the ABT is mentioned in his comments on an essay on DNA. These papers were used by the author in his biology classes, and their choice has been flavored by his findings as to usability and readability by beginning biology students. Heartily recommended for the laboratory library.

P. K.

EVOLUTION: PROCESS AND PRODUCT, Edward O. Dodson, 352 pp., $5.75, Reinhold Publishing Corporation, New York, 1960.

A traditional and straightforward second edition of a popular text in evolution. The author has produced a work which can be highly recommended for that place in the high school biology laboratory library reserved for extra reading on this topic. Of course, also it should be examined thoroughly as a possible text for the college course.

One of the fine features of the book is its teachability and usefulness in finding the information one wants to supplement the unit on evolution in the high school course. Students will find it easy to use on this score too.

The organization of the book will elaborate this view. The general units are: A Definition of Evolution, Phylogeny, The Origin of Variation, The Origin of Species and of Higher Categories, and Retrospect and Prospect. All of this without moralizing but in a careful, critical, evaluative style. While the chapter on biochemical evidences seems brief, enough is included to see that there is evidence from this area.

There are only references at the end of each chapter, but no questions or problems are included.

P.K.

THE FOREST AND THE SEA, Marston Bates, 277 pp., $3.95, Random House, New York, 1960.

A most delightful book to have in the general library of every high school. This is not to indicate that it has no value for the biology teacher or classroom student. Quite the opposite is true.

In this volume, the author, a famous biologist, looks at man, and the forest and the sea, and sees a unity of life in its ecological situation. He ranges over a wide area as ecologists should, but he is most wary of using much of their terminology for reasons carefully elaborated on in the book. His experiences in South America and other far-away places in the world are used to illustrate his theme of man's place in nature. He pleads for man to recognize that it is *this* world in which he must attempt to find his place, and that man is influenced as well as influences his biological community.

Written in a readable, delightful style, this book should appeal to the non-science student as well as the biologist. His descriptions of some of the biological communities of man will be hard to forget. It is truly a book on the ecology of man. Highly recommended.

P.K.

AO Reports on Teaching with the Microscope

Browsing in Sea Pastures... or a Study of Marine Diatoms

Every 19th century microscopist had his favorite test diatom slides. He would use them to check claims of microscope manufacturers for optical excellence. In 1848, Charles A. Spencer, our founder and America's first microscope builder, produced a microscope objective that resolved the skeletal lines of a Sigmoid Navicula ... a test diatom that made all other test diatoms seem mere childs' play. So astounding was this feat that the diatom was renamed "Navicula Spencerii".

Understandably then, we are partial to any experiment concerning diatoms. Here is such a one. And we would like to remark that we still put the proud name, "Spencer", on every microscope we make, from the simplest student model to the most advanced research type. This name is your guarantee of top quality.

Anyone who has periodic access to *any* body of water can make comparative measurements of variety and kinds of diatoms to be found at various points. This could be done in both marine and fresh water areas, such as bays, ponds, estuaries, lakes, pools and similar environments.

EXPERIMENT

A Study of Marine Diatoms

By: *Sister Jeanne Francis*
Incarnate Word Academy
2930 South Alameda
Corpus Christie, Texas

MATERIALS AND PREPARATION:

A. Remove the top and bottom from a wooden slide box. Place microscope slides in grooves and cover entire box with *wide mesh* hardware cloth. Hold in place with galvanized wire. Soak clothesline rope or sash cord in melted paraffin and affix it around the box with wire. Use enough rope so that box can be suspended in water from a pier.

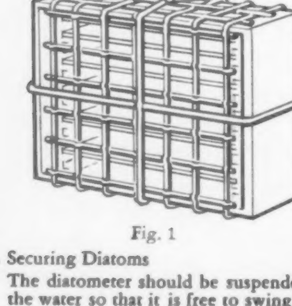


Fig. 1

B. Securing Diatoms

The diatometer should be suspended in the water so that it is free to swing with wave motion without bumping up against piles or pier supports. Site selected should have water deep enough to prevent bottom feeders from preying upon organisms deposited on the slides. Tidal variations common to the area must be taken into consideration for it is important that the box be kept in the photosynthetic zone as much as possible; roughly, within one foot is best unless water is unusually turbid, in which case, it should be somewhat less.

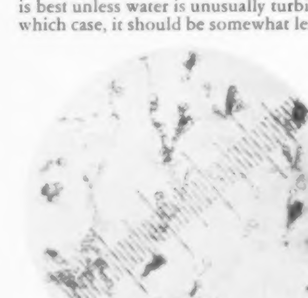


Fig. 2

Two week's submersion should be adequate. Even heavily contaminated waters will show results by this time, although there is likely to be little diversity of diatom species, and larger number of zooplankters may be present (See Fig. 2).

When taking the box back to the laboratory, keep it in a battery jar, or similar container, in water taken from the test site. Examine as soon as convenient since predators among the organisms may change the population pattern originally present.

C. Microscopic Examination

Remove rope and wire covering from the box. Select Petri dish with very flat bottom and place three drops of water, taken from test site, across the diameter. Using forceps or tweezers, transfer a slide from open diatometer to Petri dish, being careful to place slide on the line of water. If base underneath is not completely wet, add more water under the edge.

Then place three drops across the top of the slide and place three 22mm. square cover slips on the slide, thereby covering entire slide with cover slips (Fig. 3).

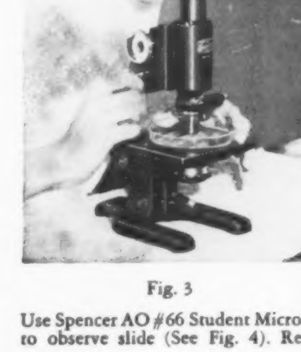


Fig. 3

Use Spencer AO #66 Student Microscope to observe slide (See Fig. 4). Remove high power objective and slide clamps to allow room for maneuvering Petri dish. Natural lighting, either daylight or a daylight-type microscope lamp, is best, since goldenbrown color of diatoms shows up clearest under daylight.

Low power observation is sufficient for surveying the field to observe diatoms present. Some protozoans may be present and all motile forms are quite active in freshly obtained specimens.

To make a quantitative survey, begin counting at top left of slide and work down, in rows, moving over a bit each time. Each cover slip area will yield five or more rows in a rough count; edges of the cover slips will serve as "landmarks". If a count is desired it will be necessary to differentiate between the forms present.

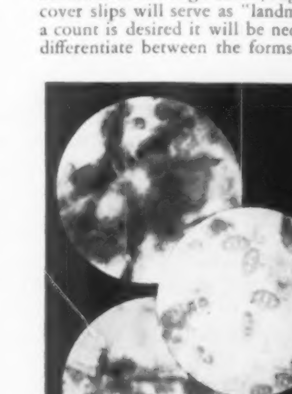


Fig. 4

OBJECTIVES:

To become acquainted with one of the principal resources of the "pasture of the sea"... marine diatoms, and coincidentally, with some of the other planktonic organisms found in the same environment. Also to familiarize the student with some of the investigative procedures and research techniques of the scientist.

The student scientist may wish to make investigations of conditions in his own area. Scientific publications on oceanography and limnology will give more detailed directions concerning techniques employed, gathering of data, interpreting results, and drawing valid conclusions.